

# **Fishery Management Report for Sport Fisheries in the Upper Tanana River Drainage in 1999**

by  
**James Parker**

October 2000

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Alaska Department of Fish and Game

Division of Sport Fish



## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

Weights and measures (metric)		General		Mathematics, statistics, fisheries	
centimeter	cm	All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.	alternate hypothesis	$H_A$
deciliter	dL	All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.	base of natural logarithm	e
gram	g	and	&	catch per unit effort	CPUE
hectare	ha	at	@	coefficient of variation	CV
kilogram	kg	Compass directions:		common test statistics	F, t, $\chi^2$ , etc.
kilometer	km	east	E	confidence interval	C.I.
liter	L	north	N	correlation coefficient	R (multiple)
meter	m	south	S	correlation coefficient	r (simple)
metric ton	mt	west	W	covariance	cov
milliliter	ml	Copyright	©	degree (angular or temperature)	°
millimeter	mm	Corporate suffixes:		degrees of freedom	df
		Company	Co.	divided by	÷ or / (in equations)
		Corporation	Corp.	equals	=
		Incorporated	Inc.	expected value	E
		Limited	Ltd.	fork length	FL
		et alii (and other people)	et al.	greater than	>
		et cetera (and so forth)	etc.	greater than or equal to	≥
		exempli gratia (for example)	e.g.,	harvest per unit effort	HPUE
		id est (that is)	i.e.,	less than	<
		latitude or longitude	lat. or long.	less than or equal to	≤
		monetary symbols (U.S.)	\$, ¢	logarithm (natural)	ln
		months (tables and figures): first three letters	Jan,...,Dec	logarithm (base 10)	log
		number (before a number)	# (e.g., #10)	logarithm (specify base)	log <sub>2</sub> etc.
		pounds (after a number)	# (e.g., 10#)	mid-eye-to-fork	MEF
		registered trademark	®	minute (angular)	'
		trademark	™	multiplied by	x
		United States (adjective)	U.S.	not significant	NS
		United States of America (noun)	USA	null hypothesis	$H_0$
		U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)	percent	%
				probability	P
				probability of a type I error (rejection of the null hypothesis when true)	$\alpha$
				probability of a type II error (acceptance of the null hypothesis when false)	$\beta$
				second (angular)	"
				standard deviation	SD
				standard error	SE
				standard length	SL
				total length	TL
				variance	Var
Weights and measures (English)					
cubic feet per second	ft <sup>3</sup> /s				
foot	ft				
gallon	gal				
inch	in				
mile	mi				
ounce	oz				
pound	lb				
quart	qt				
yard	yd				
Spell out acre and ton.					
Time and temperature					
day	d				
degrees Celsius	°C				
degrees Fahrenheit	°F				
hour (spell out for 24-hour clock)	h				
minute	min				
second	s				
Spell out year, month, and week.					
Physics and chemistry					
all atomic symbols					
alternating current	AC				
ampere	A				
calorie	cal				
direct current	DC				
hertz	Hz				
horsepower	hp				
hydrogen ion activity	pH				
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

***FISHERY MANAGEMENT REPORT NO. 00-9***

**FISHERY MANAGEMENT REPORT FOR SPORT FISHERIES IN THE  
UPPER TANANA RIVER DRAINAGE IN 1999**

by  
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## **PREFACE**

The goals of the Sport Fish Division of the Alaska Department of Fish and Game are to conserve wild stocks of sport fish, to provide a diversity of recreational fishing opportunities, and to optimize social and economic benefits from recreational fisheries. This report provides sport fisheries management information for 1998/1999 within the Upper Tanana Management Area, commonly referred to as “Delta Area”. Management strategies developed in this report are a result of biological assessment (current and prior research projects), and input from user groups. Reviews of these strategies are done on an annual basis. Research prioritization occurs during the “area review” process prior to each field season. Other information included in this report is a description of the fisheries regulatory process, the geographic boundary of the area, angler access information, and the Stocked Waters Program within the Upper Tanana River Management Area. Funding sources for management of the Upper Tanana River come from a combination of State of Alaska Department of Fish and Game (ADF&G) and Federal Aid in Fisheries Restoration (D-J) monies. The D-J funds are provided to the states at a match of up to three-to-one with the F&G funds. There is also an amendment to the D-J Act (the Wallop-Breaux amendment) that provides money to states for boating access projects. Funding for research on the Goodpaster River Arctic grayling resource comes from a private industry contract (TECK Corporation).

## INTRODUCTION

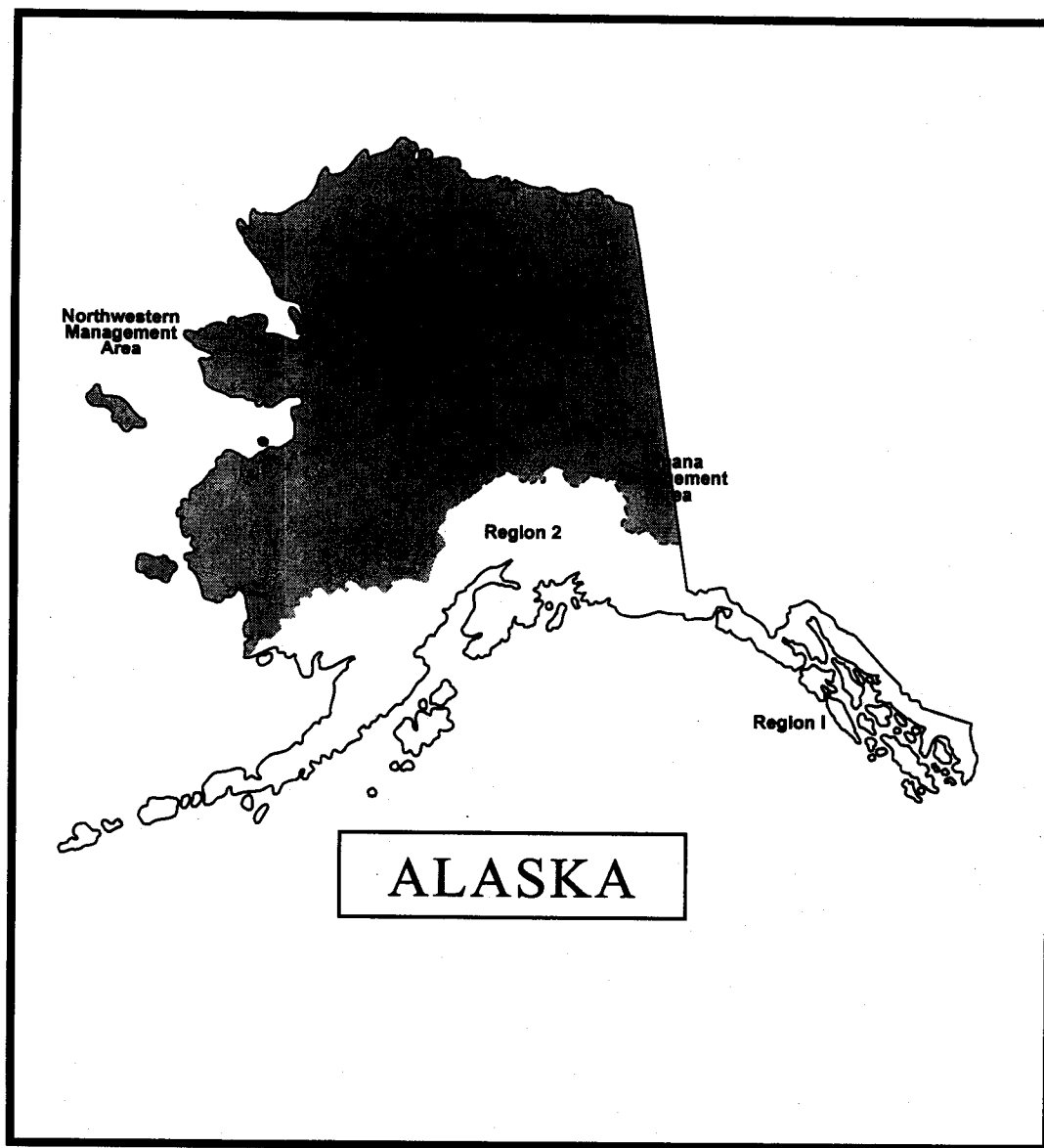
The Alaska Board of Fisheries (BOF) divides the state into ten regulatory areas for the purpose of organizing the sport fishing regulatory regime by drainage and fishery. These areas (not to be confused with Regional management areas) are described in Title 5 of the Alaska Administrative Code (5 AAC). The Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) divides the state into three administrative regions with boundaries roughly corresponding to groups of the BOF regulatory areas (Figure 1). Region I is equal to Southeast Alaska, Region II covers portions of South-central Alaska, Kodiak, Southwestern Alaska, the Aleutian Islands and Bristol Bay, and Region III includes two and most of a third of the BOF fishery regulatory areas. They are the Upper Copper and Upper Susitna regulatory areas, most of the Arctic-Yukon-Kuskokwim regulatory area, and the Tanana River drainage. A portion of the Arctic-Yukon-Kuskokwim regulatory area is included in Region II (Kuskokwim River drainage from the Aniak River downstream).

Region III is the largest geographic region, encompassing the majority of the landmass of the state of Alaska (Figure 2). The region contains over 1,251,300 km<sup>2</sup> (485,000 mi<sup>2</sup>) of land, some of the state's largest river systems (the Yukon, portions of the Kuskokwim, the Colville, Noatak, and upper Copper River and upper Susitna River drainages), thousands of lakes, and thousands of miles of coastline and streams. Regional coastline boundaries extend from Sheldon Point in the southwest, around all of western, northwestern and northern Alaska to the Canadian border on the Arctic Ocean. Region III as a whole is very sparsely populated, with the most densely populated center located in the Tanana River valley; Fairbanks (population about 31,000) is the largest community.

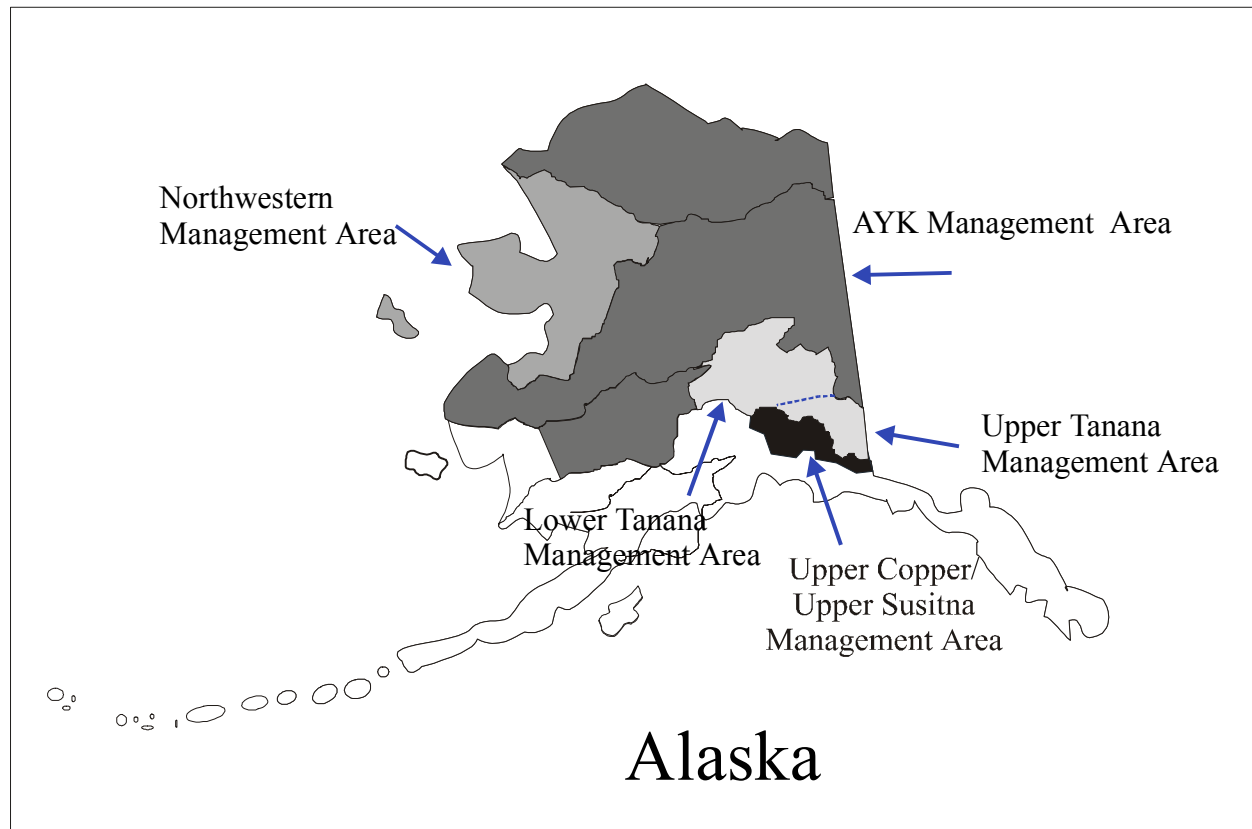
For administrative purposes the Sport Fish Division has divided Region III into five fisheries management areas (Figure 2). They are: Northwestern Management Area (Norton Sound, Seward Peninsula and Kotzebue Sound drainages); AYK Management Area (the North Slope drainages, the Yukon River drainage except the Tanana River drainage, and the Kuskokwim River drainage upstream from the Aniak River); Upper Copper/Upper Susitna Management Area (the Copper River drainage and the Susitna River drainage above the Oshetna River); Upper Tanana River Management Area (The Tanana River drainage upstream from Banner Creek and the Little Delta River); and, Lower Tanana River Management Area (the Tanana River drainage downstream from Banner Creek and the Little Delta River). Area offices for the five areas are located in Nome, Fairbanks, Glennallen, Delta Junction, and Fairbanks, respectively.

The Tanana River drainage is divided into two separate management areas because it contains population centers that result in a large amount of angling effort on local fishery resources. Intensive, stock specific studies are required in the Tanana drainage to provide biological and fishery management information because of the higher fishery exploitation rates. This report details the management activities in the Delta area.

The Alaska Board of Fisheries (BOF) is the seven-member board that sets fishery regulations and harvest levels, allocates fishery resources, and approves or mandates fishery conservation plans for the State of Alaska. Board members are appointed by the Governor and must be confirmed by the legislature. Board members are appointed for three years. Statewide fisheries issues may be considered at any BOF meeting. Under



**Figure 1.-Map of sport fish regions in Alaska.**



**Figure 2.-Map of five management areas in Region III.**

the current operating schedule, the BOF considers fishery issues for regulatory areas or groups of regulatory areas on a three-year cycle. The BOF meetings are usually in the wintertime, between early October and late March. Regulation proposals and management plans are received for evaluation by the BOF from ADF&G, local advisory committees, and the public (any Alaskan can submit a proposal to the BOF). During its deliberations the BOF receives input and testimony through oral and written reports from staff of the Alaska Department of Fish and Game, members of the general public, representatives of local Fish and Game Advisory Committees, and special interest groups such as fishermen's associations and clubs.

Under the Alaska National Interest Lands Conservation Act (ANILCA) the Federal Government requires the State of Alaska to establish subsistence use of fish and game by rural residents as the top priority of possible uses, and establishes rules to which that State priority must conform. This is unconstitutional under State law, which requires equal access to those resources for all citizens. Should the State not amend the constitution of the State of Alaska to comply with the Federal law, managers of Federal Lands in Alaska are obligated by ANILCA to implement that priority on Federal lands.

A Federal System has been created that establishes ten federally funded Regional Advisory Councils (RAC's) providing recommendations to the Federal Subsistence Board to ensure that the rural priority for fish and game use is implemented on Federal lands statewide. The RAC's make recommendations to a Federal Subsistence Board, which then codifies them into Federal law. As of 1998, implementation of this system to regulate Alaska's fisheries on Federal land had been delayed. During this reporting period RAC's met only to consider wildlife use proposals.

The ADF&G has emergency order (E.O.) authority (5 AAC 75.003) to modify time, area, and bag and possession limit regulations. Emergency orders are implemented to deal with conservation issues that arise that are not adequately controlled by existing regulations. In that scenario, they deal with the situation until it is resolved or the BOF can formally take up the issue. Emergency orders are also the mechanism by which "in-season" management of fisheries is accomplished. In-season management is usually in accordance with a fisheries management plan approved by the BOF.

The Region III Sport Fish Division staff are organized into a research unit and a management unit. The management staff consists of a management supervisor, an area management biologist for each of the five management areas, one or more assistant area management biologists, and two stocked waters biologists. The area biologists evaluate fisheries and propose and implement management strategies through plans and regulations in order to meet Divisional goals. Interaction with the BOF, Advisory Committees, and the general public is an important part of their job. The stocked waters biologists plan and implement the Regional stocking program for recreational fisheries.

The research unit consists of a research supervisor, six research biologists (in 1998), and various field assistants. The research biologists plan and implement fisheries research projects in order to provide information needed by management biologists to meet Divisional goals. The duties of the management and research biologists overlap somewhat.

Recreational angling effort, catch, and harvest of important sport fish species in Alaska has been estimated and reported annually since 1977 (Mills 1979-1994; Howe et al. 1995-1999). These estimates are done through the statewide harvest survey; a questionnaire mailed out to a random selection of sport fish license purchasers. Estimates for a particular year usually become available in September of the following year. Effort, catch, and harvest are estimated on a site-specific basis, but estimates of effort directed toward a single species and the resulting species-specific catch-per-unit-effort (CPUE) information is not provided by the report. Utility of the estimates is strongly dependant on the number of responses for a site (Mills and Howe, 1992). Estimates based on 12 or less responses are useful only to document that fishing occurred. Twelve to 29 responses produce estimates useful for indicating relative order of magnitude and for assessing long-term trends, and estimates based on 30 or more responses generally provide estimates with reasonable variance.

This report summarizes fisheries information for 1998. This report is organized into two major sections. Section I provides an overview of the Delta area. Included is a Delta area description, Board of Fisheries activities, and information pertaining to management, stocking, research, and access program activities conducted. Section II provides a more detailed summary of each fishery and has special management concerns identified during the reporting period. Included in these summaries are; a fishery description, fishery management objective, a description of recent performance of the fishery; a description of recent Board of Fishery actions related to the fishery, a discussion of social or biological issues that may be associated with each fishery, a summary of current research and management activities related to each fishery, and a outlook for the 2000 fishing season.

## **SECTION I: MANAGEMENT AREA OVERVIEW**

The Tanana River is the second largest tributary of the Yukon River. The Tanana River basin (Figure 3) drains an area of approximately 116,500 km<sup>2</sup> (11.7 million ha). The main river is a large glacial stream formed at the confluence of the Chisana and Nebesna rivers near Tok. The Tanana River flows in a generally northwest direction for some 917 km. The Tanana drainage is split into the Upper Tanana and Lower Tanana management areas because of the intensive effort and high sport fishery exploitation levels in this region of Alaska. Sport fishing effort in the Tanana River drainage was 137,597 angler-days (71% of the total Region III effort and 7.1% of the State of Alaska total; Howe et al. 1999). During this reporting period Mike Doxey has replaced Jerry Hallberg as Area Management Biologist for the Fairbanks area. Fronty Parker, Area Management Biologist stationed in Delta Junction, manages the Delta area. Dave Davenport a Fish and Game Technician II, provides fishery information for six months at the Delta Junction field office. William Ridder (Biologist II) conducts grayling research in the region, and is stationed at the Delta Field Office. Lucia Zaczkowski, a Field Office Assistant is partially funded by Sport Fish Division to provide fishery information at the Tok Fish and Game field office.

### **UPPER TANANA RIVER MANAGEMENT AREA DESCRIPTION**

The boundary between the Fairbanks area and the Delta area is the Fairbanks North Star Borough boundary. North of the Tanana River this leaves the Salcha River drainage



within the Fairbanks area and Shaw Creek drainage in the Delta area. The Fairbanks North Star Borough boundary crosses the Richardson Highway (near Banner Creek) at Milepost 295 (Figure 4). On the South side of the Tanana River the Western-most part of the Delta area is confined by the Matanuska-Susitna, Denali, and Fairbanks North Star boroughs, this includes the Little Delta River drainage. The Eastern-most extent of the Tanana River drainage includes the Alaska portion of the White River. The Southern-most extent of the drainage is the Tangle Lakes system (Delta River) along the Denali Highway and the headwaters of the Nabesna River at the end of the Nabesna Road. Communities located within the Upper Tanana drainage are Big Delta, Delta Junction, Fort Greely, Dot Lake, Tanacross, Mansfield, Tok, Tetlin, Northway, and Nabesna. There are unique fishing opportunities found in the Delta area, such as the high elevation waters found along the Denali Highway that support lake trout populations. These waters also have the only known Dolly Varden populations in the Tanana River drainage but these fish are not in high demand by anglers. In addition, numerous spring-fed waters near Delta Junction provide critical habitat for the largest coho salmon spawning concentration in the Yukon River. In addition to coho's spawning in the spring-fed systems, Arctic grayling migrate during the summer months to these springs as well. These are adult Arctic grayling which are larger than average therefore providing trophy sized fish in the Delta Clearwater and Richardson Clearwater rivers.

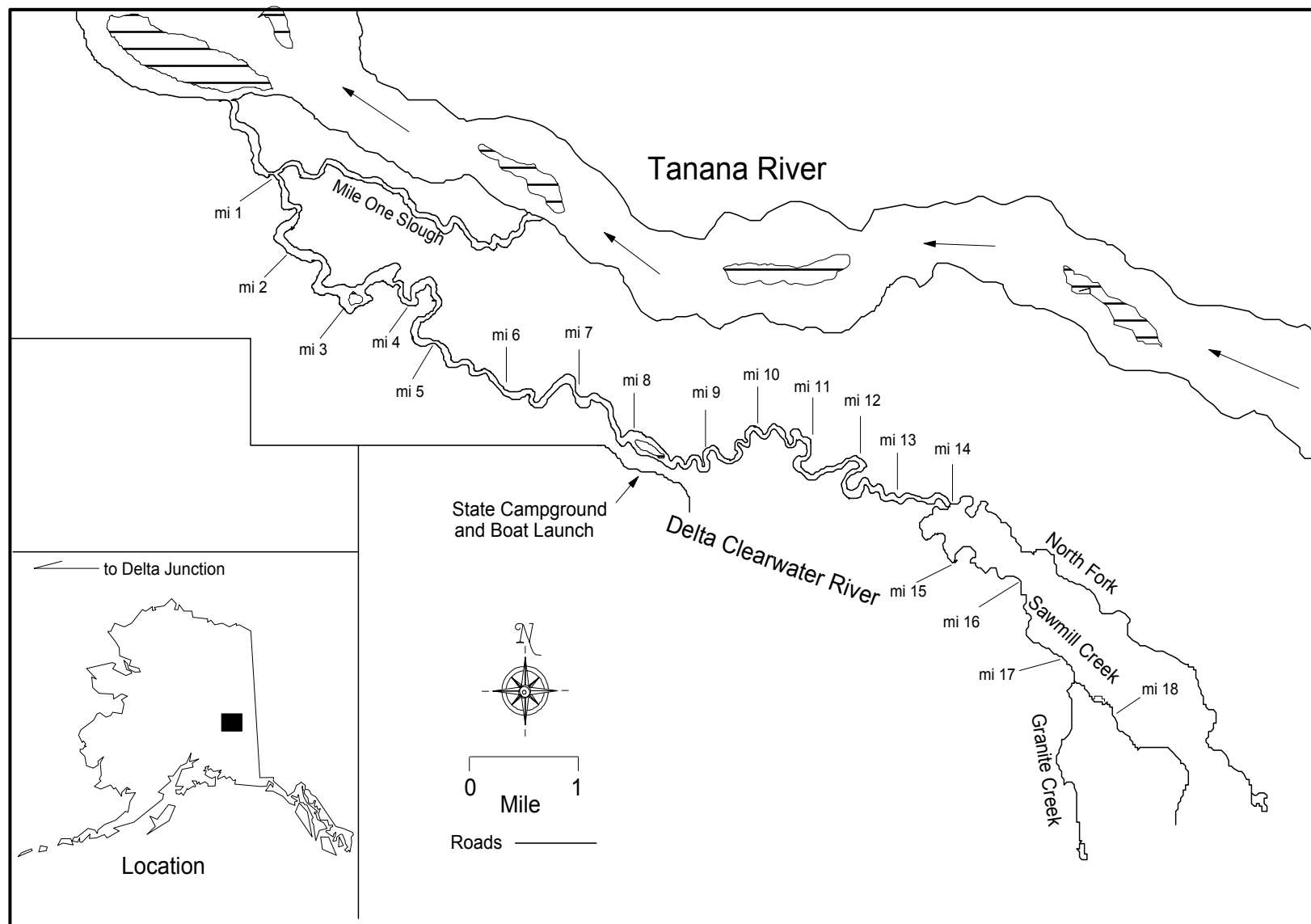
Recreational angling effort and harvest in the Tanana drainage has been estimated since 1977 using a mail-out survey (Mills 1979-1994, Howe et al. 1995-1999).

The survey is designed to provide estimates of effort and harvest on a site-by-site basis and, unfortunately, is not designed to provide estimates of effort directed towards a particular species. Effort and harvest between the two management areas within the drainage have been partitioned out and will be reviewed later in this report.

The decline in effort between 1997 and 1998 seen in the statewide harvest survey is due, at least in part, to an error in the 1995-1997 estimation process. Harvest estimates are unaffected by this error. The 1995-1997 effort estimates will be recalculated within the next year (A. Howe 1999, Alaska Dept. of Fish and Game, e-mail communication).

## **ALASKA BOARD OF FISHERIES AND ADVISORY COMMITTEES**

Regulations for the Tanana River drainage sport fisheries are found in Chapter 70 of Title 5 of the Alaska Administrative Code. Regulations for specific waters in the Delta area are under the Tanana River portion (5 AAC 70.022 d) of the Arctic-Yukon-Kuskokwim Area. The Alaska Board of Fisheries (BOF) process establishes regulations for fisheries in the Tanana drainage. Under the current operating schedule, the BOF considers regulations for all of the AYK area on a 3-year cycle. The last meeting occurred in December of 1997 and proposals concerning the Delta area for the next BOF meeting (December of 2000) are due April 10, 2000. Public input concerning regulation changes is provided for in this process through direct testimony to the BOF and through participation in local Fish and Game Advisory Committees. Advisory committee meetings allow opportunity for direct public interaction with Department staff. In this way, the public can ask questions and staff can provide clarification to proposed regulatory changes. The Boards Support Section within the Division of Administration provides administrative and logistical support for the BOF and Fish and Game Advisory



**Figure 4.-Map of the Delta Management Area within the Tanana River drainage.**

Committees. Jim Marcotte is the Interior Region coordinator, stationed in Fairbanks. There are two advisory committees in the Delta area that represent resource users: Delta and Upper Tanana/Forty Mile. The Chairman of the Delta Advisory Committee is Larry Fett; Mary Beth Hennessy is chair of the Upper Tanana/Forty Mile Committee. These two committees meet on a monthly or bi-monthly schedule throughout the fall and winter months. To address conservation emergencies between BOF meetings the Delta Area Manager has emergency order authority (5 AAC 75.003) to modify time, area, and bag/possession limit regulations. No emergency orders were issued during 1998 for the Delta area.

### **FEDERAL SUBSISTENCE REGIONAL ADVISORY COUNCIL**

The Secretary of the Interior appoints members of the Federal Subsistence Board (FSB). He also approves the members of the Subsistence Advisory Councils of which there are ten in Alaska. The FSB is responsible for customary and traditional use determinations and hunting and fishing regulations on federal land. The 10 Regional Subsistence Advisory Councils receive regional requests for federal actions on subsistence desires and identifies subsistence needs, uses, methods, and recommends allocations of resources and harvest circumstances. The Delta area is within the Eastern Interior Federal subsistence regional advisory council region (includes Game Management Units 12, 20 and 25). These regional councils to date have only to deal with wildlife issues on Federal lands. However, in 1998 discussions began as to what advisory role regional councils would have concerning fisheries if the State did not resolve the rural subsistence priority. The Federal Government would take over Fisheries Management on Federal waters by the September 1, 1999 if nothing were done. This would extend jurisdiction for fisheries to Federal inland waters on Federal selected land, land selected but not yet conveyed, recreation and conservation areas. In addition, the FSC may extend their authority off of Federal land in certain circumstances.

The Eastern Council met in Minto on October 21, 1998 and in Delta Junction on February 27-28, 1999 to cover wildlife issues proposed in 1998. Federal Lands within the Delta area are: 1) Tetlin Refuge some 730,000 acres (Figure 4) which includes much of the Nebesna and Chisana rivers, 2) Fort Greely, 661,000 acres of US Military lands near Delta Junction, 3) Delta River Wild and Scenic River corridor which is approximately 37,000 acres in size and 62 miles in length from the upper most lakes in the Tangle Lakes system to confluence of Black Rapids Glacier to the Delta River, 4) the Tangle Lakes Archaeological District which is 460,000 acres and encompasses waters along the first 35 miles of the Denali Highway from Paxson (The initial 37 miles of the Delta Wild and Scenic River corridor is included in the Archaeological district), and 5) the headwaters of the Chisana and Nabesna rivers are with the Wrangle-St. Elias National Preserve adjacent to the Tetlin National Refuge.

### **FISHERY RESOURCE INVENTORY**

There are 17 fish species known in the Delta area of which 10 are species commonly targeted by sport anglers. They include: coho salmon *Oncorhynchus kisutch*, chum salmon *Oncorhynchus keta*, Arctic grayling *Thymallus arcticus*, burbot *Lota lota*, lake trout *Salvelinus namaycush*, inconnu (sheefish) *Stenodus leucichthys*, least cisco *Coregonus sardinella*, humpback whitefish *Coregonus pidschian*, and northern pike *Esox*

*lucius*. Rainbow trout *Oncorhynchus mykiss* are not native to the drainage, but have been stocked in several locations. Arctic char *Salvelinus alpinus*, coho salmon, Arctic grayling and lake trout have also been stocked in selected waters of the Delta Area.

## **STATEWIDE HARVEST SURVEY DESCRIPTION**

Recreational angling effort in the Tanana drainage has been estimated since 1977 using a statewide mail-out survey (Mills 1979-1994, Howe et al. 1995-1999) administered by Research and Technical Services (RTS) of the Sport Fish Division. This Statewide Harvest Survey (SWHS) estimates the number of angler-days of sport fishing effort expended by recreational anglers fishing Alaskan waters as well as the catch and harvest of important sport species. The survey is designed to provide estimates of effort and harvest on a site-by-site basis; however, the survey does not provide estimates of effort directed towards a particular species. The standard questionnaire used annually since 1977 was mailed to 47,000 households containing at least one individual who purchased a 1998 sport fishing license or a valid permanent identification card for sport fishing. Each household was asked for information for 1998 on number of licensees, on participation (number of anglers, trips, and days fished), and number of fish caught and number of fish kept (harvested) by species and site. An estimate was generated for catch and harvest for each species and participation by site. Confidence intervals for estimates were calculated using the percentile method of bootstrap resampling with 1,000 replications (Howe et al. 1999). Guidelines (Mills and Howe 1992) for evaluating the utility of the estimates are: 1) other than to document that sport fishing occurred, estimates based on fewer than 12 responses should not be used; 2) estimates based on 12-29 responses can be useful in indicating relative order of magnitude and for assessing long-term trends; and, 3) estimates based on 30 or more responses are generally usable. For the larger fisheries harvest results have been consistent with onsite creel surveys (Mills and Howe 1992). For the most part the use of SWHS has replaced onsite creel surveys. Because of the timeliness of the survey results, estimates cannot be used for inseason management and are not recommended for compliance with regulatory and management policies, quotas, and guidelines (Howe et al. 1999).

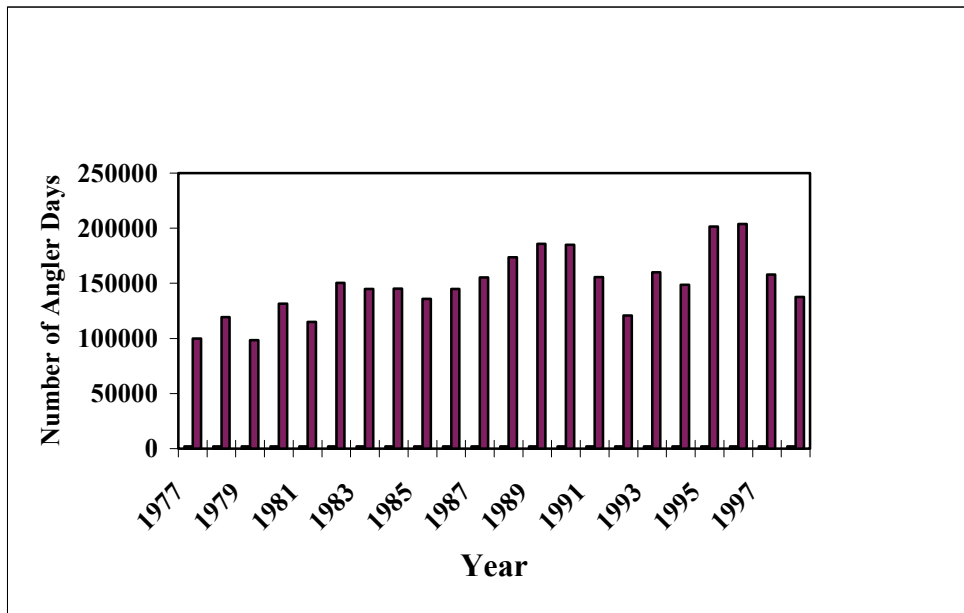
RTS discovered in 1999 that statistically significant nonresponse bias (NRB) correction factors had not been applied for recent years' estimates of effort (1995-1997). The factors were appropriately applied for 1998 and it is RTS intent to revise earlier effort estimates, if possible. NRB's were correctly applied to produce estimates of harvest which are unaffected by this error. The decline in effort between 1997 and 1998 is due, at least in part, to an error in the 1995-1997 estimation process. RTS does not intend to publish 1998 effort estimates until the questions concerning earlier estimates are resolved, which may take months. For the purposes of this report I will use the unpublished estimates of effort and revise them in next years AMR as corrected estimates become available.

## **RECREATIONAL ANGLER EFFORT, HARVEST AND CATCH**

The majority (average 71%) of sport effort in the AYK occurs in the Tanana River drainage. From 1977 through 1998, anglers in the Tanana drainage have expended an average of 148,697 angler-days or 7.1% of the total statewide effort (Table 1, Figure 5). In 1997 as well as 1998 the Tanana drainage portion dropped to 51% (Table 1) of the

**Table 1.-Number of angler-days of sport fishing effort expended by recreational anglers fishing Tanana River drainage waters, 1977-1998.**

Year	Tanana Drainage Effort	Statewide Effort	Tanana % of Statewide	Region III Effort	Tanana Drainage % of Region III
Average 1977-1981	112,878	1,351,484	8.4	140,780	80.2
1982-1986	144,242	1,847,387	7.8	195,711	73.7
1987-1991	171,063	2,327,570	7.3	231,169	74.0
1992-1996	166,990	2,668,074	6.3	237,431	70.3
1997	157,865	2,654,454	5.9	206,517	50.7
1998	137,587	2,154,868	6.4	272,574	50.5
Total	3,271,329	45,781,899		4,609,421	
Average	148,697	2,080,997	7.1	209,519	71.0



**Figure 5-Angler effort in the Tanana River drainage from 1977 - 1998.**

AYK effort due to adding the Glennallen Management Area (Upper Copper and Upper Susitna River drainage's) to the AYK Region in 1997 (Parker 2000). The fraction of statewide effort expended in the Tanana drainage in 1998 was 6.4% slightly below the 21-year average (Table 1).

From 1977 through 1998, recreational anglers in the Tanana drainage harvested an estimated 2,956,275 fish, accounting for an average of 4.5% of the annual estimated statewide recreational fish harvest and about 69.2% of the total estimated AYK harvest for the same period (Table 2). Sport harvest of all species since 1977 in the Tanana drainage reached a peak in 1988 when over 198,000 fish were harvested (Mills 1989). Total harvest has declined to a low of 64,000 fish in 1997 but increased to 78,000 in 1998, still well below the 1977-1998 average harvest of 134,000 (Table 3). The harvest of fish in the Delta Area for 1998 was 39,125 fish or 50% of the harvest in the Tanana River drainage (Table 2), which is up over 14,000 fish from 1997, when harvest was 24,976 fish (Table 2).

Arctic grayling was the most harvested species in the Tanana drainage until 1998 (Parker and Viavant 1999). Since then, rainbow trout have dominated harvests, accounting for 49.3% of the total Tanana drainage harvest in 1998 (Table 4). In the Tanana drainage a greater portion of spawning coho salmon and indigenous lake trout were caught in the Delta area, 79% and 70%, respectively (Table 4). Half of the rainbow trout harvested as a result of ADF&G's stocking program were caught in Delta area lakes (Table 4). In 1998, Arctic grayling accounted for 17.5%, landlocked coho salmon 17.7%, northern pike 3.2%, and burbot 3.0%, respectively, of Tanana drainage harvest (Table 4). Rainbow trout and landlocked salmon, both stocked fish, represented 67.2% of the total harvest in the Delta Area (Table 4). Combined, chinook salmon, chum salmon, and inconnu (sheefish) account for less than one percent of the total Delta Area harvest in 1998 (Table 4).

Estimates of the number of fish caught and released by recreational anglers fishing Tanana drainage waters became available for the first time during 1990. Estimates of catch (which includes harvest) for this reporting period come from the statewide mail survey (Howe et al. 1999). A total of 420,724 fish were caught in the Tanana drainage of which 156,661 (37.2%) were caught in the Delta area (Tables 5 and 6). Recreational anglers kept 18.5% of their catch in 1998 in the Tanana drainage (Table 5).

While anglers in the Delta area portion of the Tanana drainage harvested more (25%), with nearly every species having a higher harvest rate (Tables 5 and 6), whitefish in the Delta area were harvested at a higher proportion (94%) than in the rest of the Tanana drainage (38%). Burbot, which are typically harvested, rather than released, were harvested the same in the Tanana drainage as well as the Delta area portion (70%). Considerable variability exists in the percent of fish released, depending on the species. For example in the Delta area, 94% of the whitefish and 70% of burbot caught in 1998 were harvested, whereas only 10% of Arctic grayling and 14% of the northern pike caught were harvested (Table 6). Catch-and-release may be practiced by more anglers fishing grayling in the Delta area because of restrictive regulations such as catch-and-release only on the Delta Clearwater River, for example.

**Table 2.-Effort and harvest in the Tanana River drainage and Delta Area, 1997 and 1998.**

Year	Number of anglers in Delta Area	% of Tanana Drainage	Number of trips in Delta Area	% of Tanana Drainage	Number of days (effort) in Delta Area	% of Tanana Drainage	Total harvest in Delta Area	% of Tanana Drainage
1997	19,585	57	26,997	22	39,914	25	24,976	40
1998	14,886	60	22,395	24	38,016	28	39,125	50

**Table 3.-Number of fish harvested by recreational anglers fishing Tanana River drainage waters, 1977-1998.**

Year	Tanana Drainage Harvest	Alaska Harvest	% by Tanana Drainage Harvest	Region III Harvest	% by Tanana Drainage Harvest
Average 1977-1981	134,947	2,459,475	5.5	178,809	75.5
1982-1986	173,185	3,058,086	5.7	250,262	69.2
1987-1991	161,588	3,249,825	5.0	222,965	72.5
1992-1996	188,045	3,213,867	5.9	253,437	74.2
1997	63,925	3,294,273	1.9	140,473	45.5
1998	78,020	3,125,941	2.5	181,808	42.7
1977-1998	2,956,275	66,078,412		4,274,124	
Average	134,376	3,003,564	4.5	194,278	69.2

**Table 4.-Number of fish harvested and caught by recreational anglers fishing Tanana River drainage waters, including the proportion within the Delta area, 1998.**

Species	Tanana River Harvest	Delta Area Harvest	% Delta Harvest	Tanana River Catch	Delta Area Catch	% Delta Catch
Salmon:						
Chinook	498	6	.001	2,601	19	0.7
Coho <sup>a</sup>	762	603	1.5	3,051	2,398	78.6
Coho <sup>b</sup>	11,984	6,928	17.7	34,788	16,258	46.7
CHUM	76	5		1,130	5	0.4
Non-Salmon:						
Rainbow Trout	38,437	19,372	49.6	112,441	50,259	44.7
Lake Trout	670	471	1.2	3,595	2,520	70.1
Char <sup>c</sup>	4,289	1,887	4.8	9,913	4,574	46.1
Arctic Grayling	12,741	6,872	17.5	214,526	68,834	32.1
Northern Pike	4,404	1,273	3.2	31,057	8,770	28.2
Whitefish	635	351	.08	1,685	374	22.2
Burbot	3,295	1,193	3.0	4,591	1,714	37.3
Sheefish	60	21	.05	236	53	22.5
Other Fish	169	143	0.4	1,110	883	79.5
Total	78,020	39,125	50.1	420,724	156,661	37.2

<sup>a</sup> Anadromous salmon.

<sup>b</sup> Landlocked coho and chinook salmon.

<sup>c</sup> Includes Arctic char and Dolly Varden.

**Table 5-Number of fish caught and harvested (kept) by recreational anglers fishing Tanana River drainage waters during 1998.**

Species	Catch	Harvest	Percent Harvested
<b>Salmon:</b>			
Chinook	2,601	498	19.1%
Coho <sup>a</sup>	3,051	762	25.0%
Coho <sup>b</sup>	34,788	11,984	34.4%
Chum	1,130	76	6.7%
<b>Non-Salmon:</b>			
Rainbow trout	112,441	38,437	34.2%
Lake trout	3,595	670	18.6%
Char <sup>c</sup>	9,913	4,289	43.3%
Arctic grayling	214,526	12,741	5.9%
Northern pike	31,057	4,404	14.2%
Whitefish	1,685	635	37.7%
Burbot	4,591	3,295	71.8%
Sheefish	236	60	25.4%
Other fish	1,110	169	15.2%
Total	420,724	78,020	18.5%

<sup>a</sup> Anadromous salmon.

<sup>b</sup> Landlocked coho and chinook salmon

<sup>c</sup> Includes Arctic char and Dolly Varden.

**Table 6.-Number of fish caught and harvested (kept) by recreational anglers fishing the Delta area portion of the Tanana River drainage in 1998.**

Species	Catch	Harvest	Percent Harvested
<b>Salmon:</b>			
Chinook	19	6	31.6
Coho <sup>a</sup>	2,398	603	25.1
Coho <sup>b</sup>	16,258	6,928	42.6
Chum	5	5	100.0
<b>Non-Salmon:</b>			
Rainbow trout	50,259	19,372	38.5
Lake Trout	2,520	471	18.7
Char <sup>c</sup>	4,574	1,887	41.3
Arctic grayling	68,834	6,872	10.0
Northern pike	8,770	1,273	14.5
Whitefish	374	351	93.9
Burbot	1,714	1,193	69.6
Sheefish	53	21	39.6
Other fish	883	143	16.2
Total	156,661	39,125	25.0

<sup>a</sup> Anadromous salmon.

<sup>b</sup> Landlocked coho and chinook salmon

<sup>c</sup> Includes Arctic char and Dolly Varden.

## **MANAGEMENT AND RESEARCH ACTIVITIES**

All activities in Region III are directed by Regional Supervisor, Mac Minard, who delegates tasks to the Administrative Assistant (Terra Shideler), the Research Supervisor (Peggy Merritt) and the Management Supervisor (Charles Swanton). For the Delta Area, Charles Swanton directs the activities of the Area Management Biologist, Fronty Parker. Peggy Merritt directs research Biologist Bill Ridder, stationed in Delta Junction, who was responsible for Arctic grayling studies in the Tanana River drainage. Cal Skaugstad from the Fairbanks office directs Lake stocking activities. Tim Viavant also stationed in the Fairbanks office directs access projects and activities.

The management staff in Region III began drafting Fishery Management Plans in 1992 for each important fishery. Each of the plans, including those listed below for the Delta area, were finalized in 1993. Managers use the plans as annual planning and evaluation tools. In January the management staff will discuss fishery by fishery the objectives and course of action if necessary based upon these plans. To date none of these plans have been officially changed or updated. The Delta Area Plans and the date finalized are as follows:

1. Quartz Lake Stocked Lake Sport fishery, June 1992
2. Small Stocked Lakes Sport Fishery, June 1992
3. Delta Clearwater River Coho salmon fishery, April 1993.
4. George Lake sport fishery, April 1993.
5. Volkmar Lake, April 1993.
6. Tangle Lake System sport fishery, May 1993.
7. Delta Clearwater River Arctic grayling sport fishery, June 1993.
8. Fielding Lake sport fishery, June 1993.
9. Goodpaster River sport fishery, June 1993.
10. Richardson Clearwater River sport fishery, June 1993.
11. Shaw Creek sport fishery, June 1993.
12. Tanana River burbot sport fishery, June 1993.

## **COMMERCIAL SALMON HARVESTS**

Tanana River stocks of chum, chinook, and coho salmon provide commercial for fisheries in the Tanana River District. Commercial fishing is allowed by emergency order in three statistical areas (6a, b, c), from the mouth of the Tanana River to the mouth of the Chena River. Commercial fishing above the mouth of the Chena River is prohibited, precluding any commercial activity in the Delta area of the Tanana River drainage. Commercial harvests in the Fairbanks area are primarily for summer chum and chinook salmon, the later timing of coho salmon cause them to be caught incidentally. In the event of a poor run of fall chum salmon Commercial Fisheries Division may direct the fishery toward the harvest of coho salmon. The Tanana River from its confluence of the Gerstle River to the Little Delta River is crucial habitat for returning fall chum salmon. Alluvial aquifers associated with porous floodplain gravels store water and stabilize winter flows in this area near Delta Junction. All the large aquifers are located on the south side of the Tanana River. Groundwater seeps into the Tanana River,

providing habitat for chum and coho salmon, which are the last salmon species to spawn during the year. The furthest upriver chinook spawning system is the Goodpaster River with fish entering the system in July. In 1998, 2% of the total Yukon River commercial summer chum salmon harvests were caught in Tanana drainage (Table 8). For all salmon species, commercial harvest in the Tanana drainage was 2.1% of the total Yukon harvest in 1998 (Table 7). Because of the emergency closure there was no fall chum or coho salmon harvest in the Tanana drainage in 1998. Limited commercial fisheries exist for freshwater species such as sheefish, burbot, northern pike and whitefish however, the majority of the freshwater harvest is from sport and subsistence use. Commercial fisheries for whitefish have been permitted in recent years but none in 1998 (Bergstrom et al. 1999).

## **SUBSISTENCE AND PERSONAL USE SALMON HARVESTS**

Subsistence and personal-use fisheries are allowed in most of the Tanana drainage. A subsistence permit is not required for non-salmonid species from the mouth of the Tanana River up to and including the Wood River. However, a subsistence permit is needed for northern pike in the waters of the Tolovana River upstream from its confluence with the Tanana River. Subsistence fishing is closed in the Tanana River from the eastern edge of the Salcha River upstream to the mouth of the Volkmar River on the North bank of the Tanana, and the mouth of the Johnson River on the South bank of the Tanana River. In the closed area, however, whitefish and suckers can be taken under the authority of a whitefish and sucker personal-use permit. Deadman, Jan, and Fielding lakes within the Delta area of Tanana drainage are also closed to subsistence fishing. The Board of Fisheries in 1994 closed the Delta River to all forms of fishing including subsistence spearing for chum carcasses, citing the spawning area be left undisturbed (Parker 2000, *In print*). Carcasses were used primarily for dog food. Personal-use fish can be harvested using gillnets or fish wheels only taken in this fishery within a portion of the Tanana River near Fairbanks (Borba and Hammer 1999).

Upstream of the Volkmar River (N. side of the Tanana) and the Johnson River (S. bank of the Tanana River), a subsistence permit is required for non-salmonid species in the remainder of the Tanana drainage. Even though a permit is required, subsistence fisheries that target non-salmon species such as pike, inconnu (sheefish), burbot, and whitefish are inadequately documented (Bergstrom et al. 1992). The permit requirement was little known to fishermen in villages along the upper Tanana River and not enforced as of 1988 (Marcotte 1991). In 1987-1988, the harvest of non-salmon fish species accounted for 33.8% of the total edible pounds of fish and wildlife resources in Dot Lake, Tanacross, Tok, Tetlin, and Northway. Household harvests of non-salmon fish ranged from 100 to 500 pounds. The majority of the non-salmon subsistence harvest is made up of whitefish and pike (Marcotte 1991).

The Division of Commercial Fisheries Management and Development (CFMD) documents subsistence and personal-use harvest records for salmonid species. Poor returns in 1998 of chinook and summer and fall chums had a disastrous impact on subsistence, personal-use, and commercial fisheries in the Yukon River drainage (Borba and Hammer 1999). Personal-use was closed July 24, and sport fishing on the Tanana River for chinook and summer chum was restricted on July 25 to catch-and-release only. Effective August 15, the entire Yukon River drainage was closed for chum salmon. Because of the above actions, no fall chum salmon harvest occurred in the Tanana drainage (Table 8) commercial, sport or personal-use fisheries in 1998 (Borba and Hammer 1999). In 1998, subsistence and personal-use caught salmon in the Tanana drainage accounted for 13.7% of the total Yukon River subsistence and personal-use

**Table 7.-Commercial salmon harvest in the Tanana River drainage and percent of Yukon River drainage harvest in 1998 (Bergstrom et al. 1999).**

Species	1998		
	Tanana	Yukon	%
	Total	Total	Tanana
Chinook	963	42,699	2.3
Summer chum	570	28,798	2.0
Fall chum	0	0	0.0
Coho	0	0	0.0
Total	1,533	72,497	2.1

**Table 8.-Subsistence and personal-use salmon harvest in the Tanana River drainage and percent of Yukon River drainage harvest in 1998 (Borba and Hammer 1999).**

Species	1998		
	Tanana	Yukon	%
	Total	Total	Tanana
Chinook	2,276	54,090	4.2
Summer chum	6,088	86,088	7.1
Fall chum	14,372	62,869	42.1
Coho	7,481	17,781	9.5
Total	30,217	220,828	13.7

harvests (Table 7). Fall chum harvested in the Tanana drainage made up 42% of the total Yukon fall chum harvest (Table 7).

### **ECONOMIC VALUE OF SPORT FISHERIES**

An economic study of the Delta Clearwater River sport fishery was conducted in the summer of 1985. In 1985, grayling and coho salmon fishermen spent a total of about 8,700 man-days fishing in the Delta Clearwater River (Mills 1986). It was estimated that angler expenditure per fishing trip was \$113.62, and the number of fishing trips during 1985 was 5,583, for a total estimated expenditure of \$630,000 (Howe 1987). Anglers participating in the Delta Clearwater River fishery therefore expended an average of about \$75 per man-day in 1985. Since Delta area fisheries are generally remote to most of the inhabitants of the Tanana River drainage, it would be reasonable to expect an angler day of effort to cost this amount or more.

### **STOCKING PROGRAM INVENTORY**

The growth and success of the interior Alaska stocking program has been largely due to the development of, and production from, Alaska State hatcheries, particularly the Clear Hatchery and the Fort Richardson hatchery near Anchorage. The Clear Hatchery program began in 1977 with the production of chum salmon. During the last 10 years, production of sport fish species has taken precedence over anadromous salmonids at both hatcheries (Arvey 1995). Clear Hatchery was closed in 1997, and currently, all production of stocked fish released in the AYK Region occurs at the Fort Richardson and the Elmendorf hatcheries in Anchorage. The dominant game fish stocked in the Tanana drainage are rainbow trout which also supports the greatest harvest (Table 4); although, Arctic grayling are caught at a higher frequency (Table 5). Other species stocked are Arctic char, Arctic grayling, lake trout, and silver salmon. In the Delta area there are 46 lakes on the stocking inventory for 1998. Quartz Lake is the largest lake both in size (600 acres) and recreational opportunity. There were 400,000 rainbow trout, 80,000 coho salmon, and 11,000 Arctic char stocked in Quartz Lake in 1998. About half the effort at Quartz Lake is during the open water months and half during the ice-covered period (ADF&G Statewide Stocking Plan 1999). The remaining 45 lakes are considered part of the "small lakes sport fishery" with most lakes averaging 34 acres in size. These lakes are stocked either annually, or, in the case of the more remote lakes, every other year. During 1998, two previously unstocked lakes were surveyed to determine stocking suitability. Kenna Lake in the Jarvis Creek drainage is a suitable candidate and will be considered for inclusion in the inventory. The other Lake is Dude Lake in the Delta River drainage, which has indigenous Dolly Varden present in small numbers. Although Dude Lake is suitable for stocking, further consideration must be given before stocking in systems with native populations of fish.

### **ACCESS PROGRAM**

The Wallop-Breaux amendment to the Federal Aid in Sport Fish Restoration Act mandates that at least 15% of the federal funds collected from taxes on sport fishing equipment be used by the states for the development and maintenance of boating access facilities. This mandate is fulfilled by the ADF&G Sport Fish Access Program, which consists of two parts. The first part, the boating access coordination program, involves large capital improvement projects, such as boat ramps, parking areas, fishing docks, and land acquisition, which are subjected to public review under the National Environmental Policy Act. The second portion of the program is called the small access site maintenance program. The small access program is an ongoing, annually funded program. Activities include placing and maintaining signs at lake and river angling-

access sites, constructing and maintaining pedestrian and off-road vehicle (ORV) trails to fishing sites and providing portable toilets, picnic tables, and trash removal at heavily used roadside angling sites. The program also secures permanent rights-of-way on public and private land to ensure continued public access to fishing sites, maintains access roads to boating or angling sites that might not otherwise be maintained, constructs and maintains outhouses and tent platforms at remote angling sites, provides public-use ice-fishing houses for rental at several large stocked lakes, and produces and prints publications informing anglers about fishing and boat launching opportunities. The history of major and small access projects completed in the Tanana drainage from 1988 to 1994 can be found in Burr et al. 1998.

One project currently in progress in the Delta area is securing title to 37.5 acres of land, which includes the Big Delta Pond. The small access project provided money for an environmental assessment of the Big Delta Pond in 1997 and funding for a title search of the property. This pond is privately owned and the Department has been stocking catchable rainbow and Arctic char since 1992. The owner offered to donate the land to the department in March of 1996. Due to various issues, mainly questions about the land title, this donation is still in the process. No major access projects were conducted in the Delta area during the reporting period. As a future reference, the Tetlin National Refuge (Federal) has taken over a small boat ramp project on the Chisana River that the Sport Fish Division was considering upgrading. They have secured funding and plan to complete the upgrade in 1999.

## **BIOLOGICAL AND SOCIAL ISSUES IN THE DELTA AREA**

Public controversy has developed over State Division of Forestry Timber Harvest Plans along the South bank of the Tanana River. The most recent Division of Forestry (DOF) five-year plan includes six timber sales along the Tanana River from the Delta River to the Little Delta River (an approximate 30-mile reach of the Tanana River). The sales are Surprise Side, Little Delta #1, Down River, Delta Creek #3, Tanana River Salvage #4, and Whitestone Extension #2. These sales and previous ones have been reviewed by Alaska Department of Fish and Game because they require access across anadromous waters. One of DOF objectives justifying these sales is harvesting timber stands that are rapidly being eroded away by the Tanana River (DOF five-year plan FY 1998-2002).

Since the early seventies Sport Fish Division has conducted biological studies on game fish species in this 30-mile reach. Many of the studies centered on Arctic grayling movements from Tanana River overwintering areas to Shaw Creek, a spawning tributary, to summer feeding streams such as the clear spring-seeps of Richardson Clearwater River (RCR) and Clear Creek. Radio telemetry studies of fish tagged upstream in the Delta Clearwater River and other tagging studies showed that Arctic grayling from numerous stocks (i.e. Salcha, Goodpaster, and Delta rivers) overwintered in this section as well. These studies show Arctic grayling make extensive movements and have diverse habitat requirements. The area contains a large number of spring-fed sloughs that include chum salmon spawning habitat. The Divisions of Sport Fish, Commercial Fish, and Habitat have been opposed to issuing a Title 16 permit to allow road building in the area without guarantees of spawning habitat protection. The Division of Habitat identified tannic runoff and ground water habitats to the Tanana River as very important for juvenile fish (Hemming and Morris 1999). Habitat Division plans to continue juvenile studies in five habitat types in 1999, and, if funding permits, in 2000. Work will be done between the Richardson Clearwater River to Clearwater Lake on the Tanana River. This research will be

partially funded by the Department of Environmental Conservation (DEC) 319 grants, requiring a 40% match of Department of Fish and Game general fund money.

Gold exploration has led to the development of large-scale mining operations in the Tanana River drainage. The Pogo mine in the upper Goodpaster River is a world-class mineral resource development, which includes nearly 200 square miles of claims. These claims are within the GPR watershed and development may potentially influence water quality. To assess the influence mining a long-term population study on spawning Arctic grayling in the lower Goodpaster River was funded (\$11,500) in 1998 by Teck Corporation.

There are a number of management concerns regarding the federal takeover of subsistence management of fisheries in the state. These include enforceability of dual sets of regulations, public confusion over jurisdiction, potential increases in subsistence harvests related to customary trade, loss of sport fishing opportunity, and the lack of mechanisms for cooperative management of stocks supporting both subsistence and sport harvests. In October 1998, the federal take-over of subsistence management for fisheries was delayed until October 1, 1999 through an agreement between the Alaskan delegation and Secretary Babbitt. Federal takeover may have been avoided if the Alaska Legislature approved a constitutional amendment to be placed on the ballot in 2000, requiring a rural preference for subsistence. However, no constitutional amendments were placed on the ballot, and subsistence management is managed by the federal government.

## **INFORMATION AND EDUCATION PROGRAM**

The Sport Fish Division has provided information and education services to anglers, educators, interest groups, and the general public since statehood. In Delta Junction, technician David Davenport has enhanced access and acquisition of information about sport fisheries. Information provided includes a large wall map of the area with lakes and access areas marked, pamphlets, brochures, and maps. The Area Management Biologist (AMB) provides several annual aquatic education opportunities for the school district. Field trips to the Delta Clearwater River to examine water quality and fish habitat have been an annual event for the Delta Junction 7<sup>th</sup> grade class since 1988. Also, classrooms from Fairbanks and Tok have participated in collecting coho eggs from the Delta Clearwater River. The coho eggs were raised and hatched in classroom incubators, and the fish were returned to Delta Clearwater River utilizing a fish transportation permit (FTP). At least one classroom presentation is given annually to the school district or community college.

## **SECTION II: DELTA AREA RECREATIONAL EFFORT**

The Statewide Harvest Survey (SWHS) estimates the number of angler-days of sport fishing effort expended by recreational anglers fishing Alaskan waters as well as the catch and harvest of important sport species. The survey is designed to provide estimates of effort and harvest on a site-by-site basis. However, it does not provide estimates of effort directed towards a particular species. In 1998, a total of 137,587 angler-days were reported for the Tanana drainage statistical area "U". Of this Tanana drainage total, 38,016 angler-days of effort were estimated within the Delta Management area (Appendix A1). Fishing effort in the Delta Management area comprised 28% of the total effort in the Tanana River drainage (Table 2). In 1997 and 1998, more than half of the Tanana drainage anglers fished in the Delta Management area (Table 2) and these anglers harvested half of all fish harvested within the Tanana River drainage (Table 1). It appears that

anglers fishing the Delta area economize on number of fishing trips because of travel distance to fishing areas. Even though more anglers take fewer trips into the Delta area, they are successful in harvesting fish since half the harvest comes from the Delta area (Table 1). Effort data between the two management areas has been extracted only for 1997 and 1998 (Table 2). Effort declined by 1,000 angler-days from 1997 to 1998 (Table 2) in the Delta Area, this may have resulted from the error discussed earlier where the effort estimates from 1995-1997 were biased high.

### **SECTION III: COHO SALMON-DELTA CLEARWATER**

#### **BACKGROUND AND HISTORICAL PERSPECTIVE**

The Delta Clearwater River (DCR) is the largest of several spring-fed tributaries to the Tanana River and supports the largest documented spawning run of coho salmon in the in the Yukon River (Parker 1991). The DCR is about 20 miles in length, has road access (Figure 6), and provides a recreational fishery for coho salmon (ADF&G 1993). Effort estimates for coho salmon are not available from the SWHS. However, effort estimates from creel surveys of Arctic grayling during the summer subtracted from the annual SWHS indicate that 47% of all DCR effort is directed towards coho salmon. In 1998, an estimated 2,200 angler-days was aimed at the DCR coho salmon fishery.

An average of 70% of coho salmon harvested in the Tanana River drainage is from the DCR (ADF&G 1993). Coho salmon are the last of the salmon species to enter the Yukon River and begin to enter the DCR in mid-September. Before reaching the DCR, coho salmon travel about 1,700 km from the ocean and pass through six different commercial fishing districts in the Yukon and Tanana rivers (Parker 1991). Subsistence and personal-use fishing also occurs in each district. The peak of the run is mid-October. Property owners living near the spring have reported coho salmon spawning as late as January. The DCR provides favorable over-wintering habitat for coho salmon which rear in the river for 1-3 years.

Escapement counts are completed on 17.5 miles of navigable water from an elevated platform on a riverboat. Aerial surveys have also been used to estimate escapement into non-boatable portions of the river from 1995 to 1998 (Stuby 1999). Preliminary counts are made in September, and if it appears that the escapement goal may not be met, the sport fish bag limit is reduced or the fishery is closed by emergency order. The present bag limit is three coho salmon per day and three in possession.

This is the last open-water fishery of the year attracting both local and non-local anglers who are new to the area and want the opportunity to catch a salmon (ADF&G 1993).

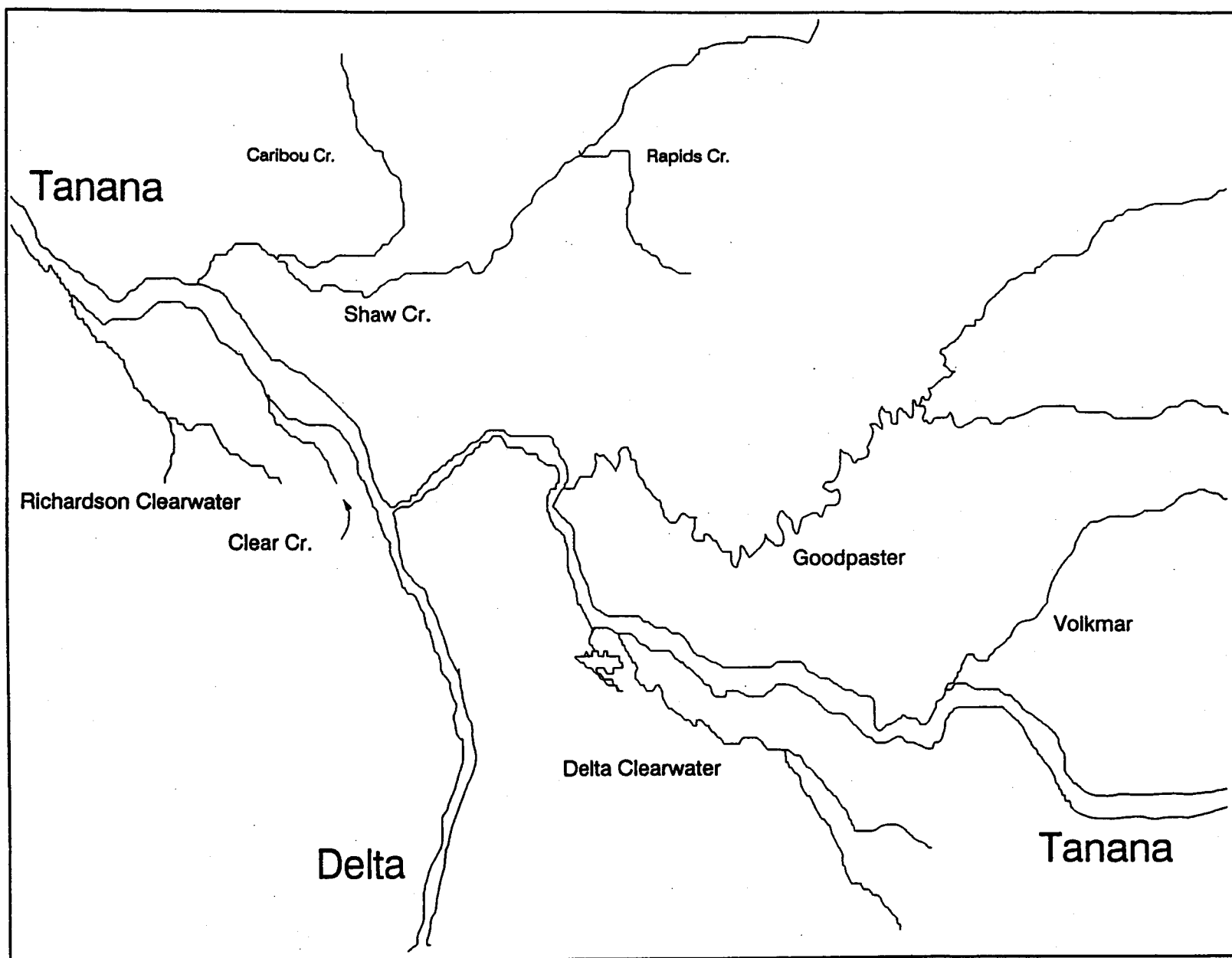


Figure 6.-Map of the Delta Clearwater River.

Anglers' fish from shore or by boat near the State Park campground and boat launch at river mile 8.5. Coho salmon are caught from mid-September through October with rod and reel using various spoons, or large spinners.

## **RECENT FISHERY PERFORMANCE**

The coho salmon fishery on the DCR is relatively new, growing in popularity since 1984. As the Arctic grayling fishery declined in 1987 a growing coho fishery buffered the decline in effort in the DCR (Table 9). Initially harvest rates were high, with exploitation up to 16% in 1990. Starting in the 1992 the harvests were below 1,000. The catch rates did not decline like the harvest during this time, which demonstrated that anglers became more interested in catch rather than harvesting. The quality of the salmon flesh is not as desirable as fish caught at the mouth of the Tanana River for example, which are still bright silver. The run in 1998, similar to that of 1997, was nearly two weeks late. Reports of strong lower river test wheel catches postponed the need for an emergency order to restrict the sport fishery. As it turned out, the 1998 escapement of 11,100 (Table 9) was above the escapement objective of 9,000 fish, and only 4.3% of the total escapement was harvested in 1998 (Table 9).

Aerial counts for coho salmon in the non-navigable portions of the DCR were conducted from 1994 to 1998. These counts comprised 21.9%, 23.8%, 19%, 17.1%, and 20.0% (averaging 21.3%) of the expanded escapement respectively (Evenson 1995-1997 and Stuby and Evenson 1998, Stuby 1999). Expanded coho salmon escapement (including aerial survey of springs) for the DCR in 1994 to 1998 was 80,240, 26,383, 17,370, 13,900 and 13,875 (Table 10). The aerial count for 1998 was the last expanded count survey. The average expansion proportion of 21.3% (Table 10) will be applied to future boat counts for an expanded total escapement count.

Average total escapement (expanded count) since 1977 has been 17,194 (Table 11). Large escapements during the past five years can be attributed to above average run strength or below average harvests in the commercial and personal-use fisheries during these years and large parent-year escapements (Table 11, Bergstrom et al. 1999).

## **MANAGEMENT OBJECTIVES**

Escapement estimates of coho salmon in the DCR has steadily increased since 1972. In 1993, ADF&G set an escapement goal of 9,000 for the DCR based on the average historical boat survey escapements from 1972 to 1992 (ADF&G 1993). At that time the estimates of escapement were based upon boat counts on the navigable portion of the river (17.5 miles). Applying the average spring tributary contribution (21.3%) to boat counts since 1972, the average annual expanded count (total count), for the DCR is 10,450 fish.

The department plans to monitor the escapement between mid-September and early October to make an in-season projection. The projection is based upon 1/3 (3,000) of the escapement goal being in the lower eight miles of river (Figure 6). If the escapement goal will not be met, the department will close the fishery to the harvest of coho salmon. In addition, the department objective is for 3,000 angler-days per year targeted on coho salmon.

**Table 9.-Delta Clearwater River, coho salmon effort, harvest and catches from Statewide Harvest Survey<sup>c</sup> and escapement.**

Year	Coho Salmon Escapement <sup>a</sup>	Angler-days <sup>b</sup>			Harvest and Exploitation (%)	Coho Catch
		Both	Grayling	Coho		
1997-1981	6,214	6,280	6,159	121	45 (0.9)	N/A
1982-1986	8,732	6,819	4,628	2,191	476 (5.8)	N/A
1987-1991	17,745	5,279	2,717	2,563	1,301 (8.6)	3,827
1992-1996	22,337	4,706	2,212	2,494	524 (4.8)	2,888
1997	11,525	2,925	1,375	1,550	866 (6.2)	4,174
1998	11,110	4,100	1,927	2,173	603 (4.3)	2,350
Average 1977-1998	13,535	5,566	3,722	1,854	3,495 (5.0)	3,179

<sup>a</sup> Estimates of escapement from river boat surveys only.

<sup>b</sup> ADF&G Coho Management Plan Delta Clearwater River.

<sup>c</sup> Mills 1979-1994; Howe et al. 1995-1999, and escapement.

**Table 10.-Boat surveys and aerial surveys of the non-navigatable portion of the Delta Clearwater River for 1994-1998.**

Year	Boat count Escapement	Aerial Count Tributaries	Total Count	% in Tributaries
1994	62,675	17,565	80,240	21.9
1995	20,100	6,283	26,383	23.8
1996	14,070	3,300	17,370	19.0
1997	11,525	2,375	13,900	17.1
1998	11,100	2,775	13,875	20.0
1994-1998	23,824	6,460	30,354	21.3

**Table 11.-Commercial, subsistence, personal-use, and sport fish coho salmon harvests for the Tanana and Yukon rivers for 1998.**

Year	<u>Commercial Fish</u>		<u>Subsistence/Personal Use</u>		Tanana Sport Harvests	Tanana Total Harvests	Yukon Total Harvests	DCR Coho Escapement <sup>a</sup>
	Yukon	Tanana	Yukon	Tanana				
1998	1	0	17,782	7,481	762	8,244	18,545	13,875 <sup>b</sup>
Average 1977-98	37,494	5,334	32,066	14,071	862	19,198	72,876	17,194 <sup>c</sup>

<sup>a</sup> Expanded count to include non-navigable portions of the river.

<sup>b</sup> Actual expanded count using the aerial survey data.

<sup>c</sup> Apply average expanded counts (21.3%) to all boat counts since 1977 having no expansion surveys.

## **FISHERY MANAGEMENT**

There is room for increased effort in this fishery, as harvest rates are low and more anglers are starting to practice catch-and-release. The 1998 run was two weeks later than normal run timing. Factors involved may have been low Tanana River flows or elevated temperatures in the Yukon River. Coho salmon carcasses in the DCR are collected in November for length, sex, and age composition. In 1998, 221 carcasses were collected, of which males comprised 49%, mostly (93%) of the brood year 1995 (Stubby 1999). Females comprised 51% of the sample and the brood year 1995 comprised 91% of the sample for females (Stubby 1999).

## **FISHERY OUTLOOK**

During 1999, the run was two weeks late. Low numbers in mid-September would normally result in an Emergency Order to close the fishery to harvest. However, the test fishing in the lower Tanana River indicated a average run would occur. Due to the strong indicator, management action was postponed and the escapement goal was met without restrictive action. Peak escapement count was 11,100 fish in the navigable portion of the river; the expanded count was 13,942 fish, very similar to the 1998 estimate of 13,875 (Stubby 1999).

## **BOARD OF FISHERY ACTIONS**

Currently, there is no management plan allowing directed coho salmon commercial fishing in the Yukon-Northern Area. The fall season is managed based on the timing and stock status of fall chum salmon. The Board of Fisheries recently (December 1997) reviewed three proposals to establish a coho salmon Management Plan for the Yukon River. A management plan would allow a directed commercial fishery on coho salmon if a harvestable surplus were available. The Board tabled the proposal and directed Yukon River Drainage Fisheries Association (YRDFA) to draft a management plan and bring it before the Board.

## **CURRENT ISSUES**

The previous escapement goal of 9,000 fish was based upon counts made from a boat in the main channel of the DCR. The recent addition of aerial counts suggests utilizing an escapement goal of 10,500, when using aerial counts.

## **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

Stock composition of coho salmon harvested in down-river fisheries is unknown. Harvests of coho salmon in the Yukon and Tanana rivers area are fairly large in comparison to the documented escapement levels in the DCR. It is believed that exploitation levels on these stocks are substantial. In the Tanana River fishery (sport, commercial, subsistence, and personal-use) harvests average 113% of the DCR escapement (Table 12). Assessment of other important coho salmon producing streams within the Tanana drainage should be conducted by aerial surveys.

# **SECTION IV: ARCTIC GRAYLING – DELTA CLEARWATER**

## **BACKGROUND AND HISTORICAL PERSPECTIVE**

The Delta Clearwater River (DCR) is the largest of several spring-fed streams near Delta Junction (Figure 6). These clear springs are cool in the summer and provide ideal habitat for adult Arctic grayling. In rapid runoff rivers such as the Goodpaster River, grayling spawn during the early spring. When spawning is complete, some adults migrate to summer feeding waters such as the DCR. Grayling, however, are not known to spawn in the DCR. It is unclear how

**Table 12.-Tanana and Yukon rivers coho salmon fishery averages and percent of DCR escapement.**

Years	DCR Coho Escapement	Tanana River		Yukon River	
		All Harvests <sup>a</sup>	% of DCR Escapement	All Harvests <sup>1</sup>	% of DCR Escapement
1977-1981	7,894	6,953	93	38,055	509
1982-1986	11,093	18,196	173	83,165	791
1987-1991	22,543	34,387	161	114,802	538
1992-1996	28,569	20,782	73	57,867	204
1997-1998	17,194	19,198	118	70,422	434

<sup>a</sup> Includes commercial, subsistence, personal-use and sport caught fish.

grayling recruit to spring-fed systems, however fidelity to the spring systems is strong. The abundance of grayling populations within donor stream populations will determine how many fish migrate to spring systems. The majority of the DCR Arctic grayling population is predominately age-5 fish and older. Based upon catch-at-age estimates of abundance, the DCR declined for nearly 12 years from 1984 to 1996. It has increased, likely as a result of restrictive regulations (Figure 7). The population of grayling (age-5 and greater) averaged 8,600 from 1977 to 1989. Abundance continued to decrease through 1996 (Figure 7).

Though the DCR population appears healthy to anglers, its population has slowly decreased over time until recently. The recent increase in the population and the increase in average size has helped to create a trophy fishery. In 1998, the catch rate was 16,100, which is the highest since catch rates were reported by the SWHS in 1990 (Howe et al. 1999).

Although this fishery has become a trophy fishery, to some extent, there is a proportion of anglers which want to harvest grayling from the DCR. However it is uncertain how harvest may affect parent stocks. It is unclear what proportion of DCR grayling originate from any Tanana drainage stream.

Average exploitation on the DCR grayling population from 1977 through 1990 was 37.6% (Clark 1994), which appeared to be sustainable from 1977 to 1989. As populations of grayling fluctuated within the Tanana River drainage, the harvest rate in the DCR likely exceeded sustainability due to fluctuations in abundance of grayling from up to eight nearby rivers. Therefore, a sustainable level of harvest should not be allowed above 20% for the DCR, which maybe equivalent to a 20% harvest rate of each contributing population. In 1995 and 1996, the bag and possession limit was reduced to two fish by emergency order, resulting in an exploitation rate of 25%. However, the population continued to decline. In 1997, an emergency order was issued for catch-and-release angling only. The BOF implemented a catch-and-release only regulation in late 1997.

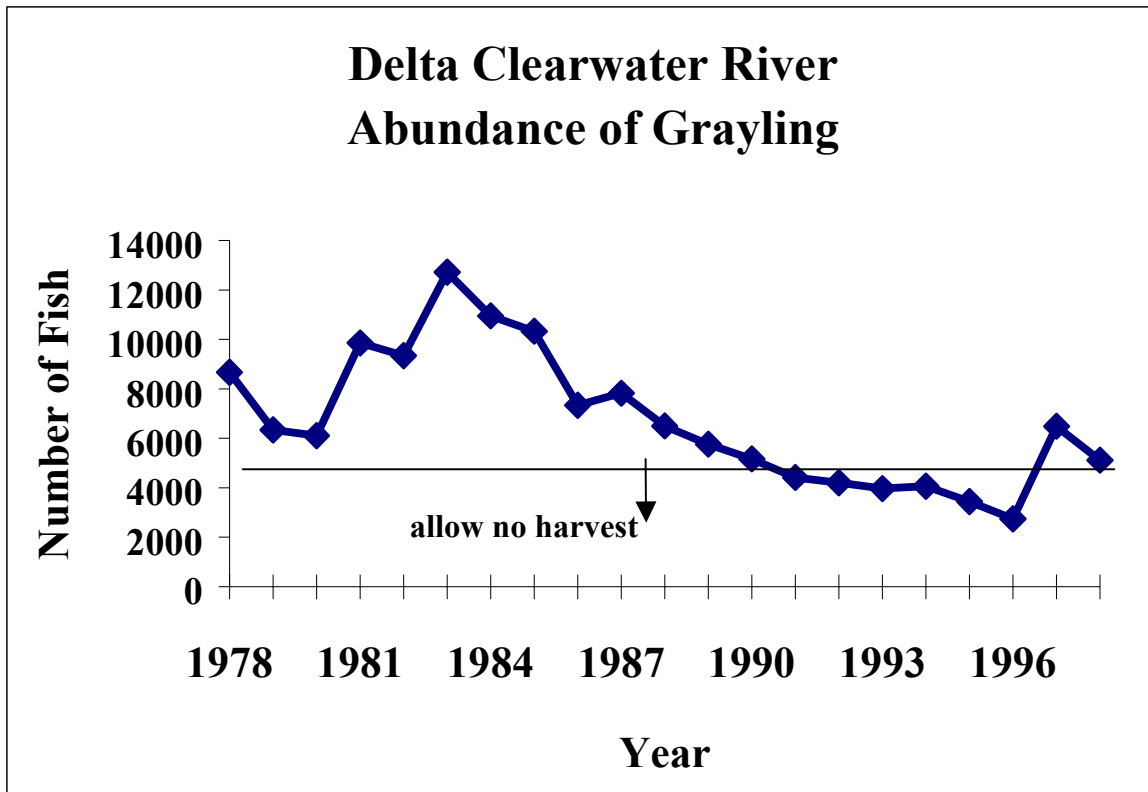
## **RECENT FISHERY PERFORMANCE**

Angler effort declined in the DCR as the grayling population declined. From 1977-1986, angler effort averaged 6,500 days of which a majority of the effort was targeted toward Arctic grayling (Ridder 1999). From 1992 to 1996 angler effort declined to an average of 2,212 days (Table 13). In 1998 effort (1,930 days) was near the 1992-1996 average level (Table 13). However, the proportion of angler days targeting Arctic grayling in 1998 may have been higher due to the late run timing of coho salmon.

No reported harvest occurred in 1998 under the catch-and-release regulations for the DCR (Table 13). Grayling catch rates averaged 6,450 grayling from 1992-1996 and 16,135 were caught in 1998 (Table 13), which was the highest ever recorded for the river.

## **MANAGEMENT OBJECTIVES**

Since the DCR is an aggregate of several stocks, the fishery will be managed on a conservative yield basis, where the biological objectives are to: 1) maintain historical stock levels, and, 2) maintain historical size and age composition. The latest management plan, implemented in 1993, has the objective of providing 3,000 angler-days of effort, a harvest of 3,000 fish and a catch rate of two fish per day fished. This management plan needs to be revised to reflect that a 3,000 fish harvest is not sustainable.



**Figure 7.-Abundance of age-5 Arctic grayling in the Delta Clearwater River from 1977 - 1998.**

**Table 13.-Number of Arctic grayling harvested and caught by recreational anglers fishing the Delta Clearwater River from 1977-1998<sup>a</sup>**

Years	Average DCR Effort	Average Grayling Effort	Average Grayling Harvest	Average Grayling Catches
1977-1981	6,280	6,159	6,662	NA
1982-1986	6,819	4,628	4,734	NA
1987-1991	5,279	2,717	2,374	11,021
1992-1996	4,706	2,212	906	6,451
1997	2,925	1,375	30	4,660
1998	4,100	1,927	0	16,135

<sup>a</sup> Mills 1978-1994, Howe et al. 1995-1999.

## **FISHERY MANAGEMENT**

Without the opportunity to harvest Arctic grayling, the DCR fishery effort and recreational opportunity experienced a decline (Parker and Viavant 2000). As a result of catch-and-release restrictions, visitors to the State campground spend fewer nights in the campground according to the local State Park Ranger (B. Ludwig, Alaska Dept. of Natural Resources, Delta, personal communication). A harvest may increase participation (angler-days), which has been short of the objective by about 1,000 days in recent years (Table 13). Most anglers fishing the river are residents who know the river well and have access to a boat. These anglers have been enthusiastic about the quality of the fishery because of the large size and catchability.

Maximum sized fish in the population can be attained by maintaining catch-and-release regulations or by allowing harvest on smaller fish. To allow a minimum harvest level of 1,000 fish, which could only occur under a very restrictive regulations package, the population would have to be at 5,000 fish. Once the population fell below this benchmark, the fishery should be catch-and-release only.

A tagging study determined that the largest contributor of grayling (22-34%) to the DCR was the Goodpaster River (Ridder 1998). In 1995 and 1996 the Goodpaster River (GPR) contributed 10% and 7% of its pre-migration population respectively to the DCR. In 1995 and 1996, the GPR stock exploitation in the DCR was 5.2% and 2.8% respectively. In addition, the GPR contributes fish to other fisheries and has its own grayling fishery for a total exploitation of 10.1% in 1995 and 6.4% in 1996. Both of these exploitation levels are within sustainable limits (B. Ridder, Alaska Dept. of Fish and Game, Delta Junction, personal communication). In 1995 and 1996, harvests were low (1,000) in the DCR because of the reduced bag limit. In previous years, during more liberal regulations, harvests averaged over 3,000 fish. The potential for a much higher, perhaps unsustainable, exploitation may have existed.

## **FISHERY OUTLOOK**

Healthy numbers of younger recruited fish to the DCR were observed for the first time in four years in 1997 and 1998 (Parker and Viavant 2000), but did not continue to be a trend in 1999. A

mark-recapture experiment was completed in 1999. Preliminary results of this survey indicate that the population is about 6,600 Arctic grayling which is an increase from the 1998 estimate of 5,100 (B. Ridder, Alaska Dept. of Fish and Game, Delta Junction, personal communication).

### **BOARD OF FISHERY ACTIONS**

In December 1997, the BOF amended proposal 195 which enacted a catch-and-release only regulation for the DCR. Additionally, the proposal was amended to add single-hook to the unbaited and artificial lure gear restrictions from January 1 to September 1. The non-single hook is used for the remainder of the year when the fishery targets coho salmon. Additionally, substitute language included the Clearwater Lake drainage with the same regulation to avoid enforcement issues.

### **CURRENT ISSUES**

In 1998 16,135 grayling were reported caught in the SWHS (Table 13). This would equate to each fish in the river having been caught an average of nearly four times. The high catch is probably responsible of mortality although minimal (McKinley 1993), but even a low hooking mortality rate could be significant with such high catch rates. Because catchability is great (over eight fish per day, Table 13), opening the fishery to harvest will have to be limited.

### **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

Estimates of abundance of the DCR population should continue to assess the need of the no harvest regulation.

Two observers snorkeling the river obtained three replicate visual counts of adult Arctic grayling in the Delta Clearwater River. Counts of the surveyed area were made in one-mile segments from river mile 14 to 3. The average total count for all three replicates was 1,915 (SE = 99). This represents 33% of an estimate obtained by mark-recapture methods. Snorkel counts were highly variable between replicates of the same river mile (cv's ranged from 9% to 55%), but variability of the total count between replicates was low (cv = 5%). Tim Viavant describes an alternative snorkeling method for estimating grayling abundance in the DCR which results in substantial savings in cost and manpower; this written study is found in Appendix B.

Management activities will continue to ensure protection of aquatic habitat for healthy fish production. Starting in 1999, the National Resource Conservation Service (NRCS) began implementing a watershed project that will prevent sediment-bearing waters of the Granite Mountains from entering the DCR. Additionally, baseline data on habitat characters should be collected and monitored for changes in the future.

## **SECTION V: DELTA AREA LAKE TROUT**

### **BACKGROUND AND HISTORICAL PERSPECTIVE**

Since 1986, lake trout populations in the Upper Tanana drainage have declined and restrictive regulations exist on many area lakes. Specific life history features (slow growth, delayed maturity and non-consecutive spawning) combined with the short growing season at higher altitudes increases the vulnerability of the species to overharvest (Burr 1987). The impact of even modest fishing pressure can be significant. Lakes containing lake trout in the Delta area include Fielding, Two Bit, Landmark Gap, Glacier, Sevenmile, and the Tangle lakes. In addition, lake trout are transplanted in several Delta Area lakes; Chet, Crystal Lake #2, Ghost,

Nickel, and North Twin lakes along the Meadows Road (Fort Greely); Paul's Pond along Coal Mine Road; and, 4-Mile Lake on the Taylor Highway.

Lake trout typically inhabit deep, oligotrophic mountain lakes. Lake trout move into shallow rocky shoals to spawn in late fall. Lake trout spawn for the first time at ages ranging from five to 12 years of age, depending on growth conditions. Alternate year spawning may be more normal than spawning in concurrent years in interior and northern Alaska.

### **RECENT FISHERY PERFORMANCE**

Tanana River drainage lake trout harvest in 1988 was 10% of the statewide harvest (Howe et al. 1999). In 1998, 70% of the Tanana drainage lake trout harvest occurred in the Delta area. Harvests in 1997 and 1998 (700) has declined from the past five-year average (1,211) and more so over the past 21 years since 1977 (1,499, Table 14). This may be in due to either declining size of fish in lakes or angler preference for releasing fish. The average catch rate has been very consistent since 1990 (Table 14). An average of 32% of the lake trout harvested since 1992 in the Tanana drainage came from stocked lakes (Table 14).

### **MANAGEMENT OBJECTIVES**

Lake trout fisheries such as Fielding Lake are managed based upon a harvest guideline to prevent excessive harvest and allow recovery of heavily fished populations. The current harvest guideline is to prevent harvest levels from exceeding 0.5 kilogram per hectare annually.

### **FISHERY MANAGEMENT**

Management actions using a guideline of 0.5 Kg/ha/yr. have been successful in regulating harvest to an acceptable level (Burr 1993). In 1987, new regulations restricted the daily bag and possession limit to two fish per day with no size limit. However, in Fielding Lake, harvests averaged 230 fish per year from 1987-1991, when harvests according to the guideline should have been 80 fish. In 1993 the bag and possession limit was reduced to one fish by emergency order and the size limit raised to 22 inches. This effectively dropped the harvest levels. From 1994 to 1998 harvest dropped to a sustainable average harvest of 41 lake trout annually (Table 14). In 1998, the Fielding Lake harvest was 21 lake trout (Table 14) within the guideline of about 80 fish per year. However, it is suspected that the population had dropped resulting in a low harvest.

**Table 14.-Summary of sport harvest and catch<sup>a</sup> of lake trout in the Tanana River drainage<sup>b</sup>.**

Year Harvest	Harding Lake	Fielding Lake	Tangle Lake <sup>c</sup>	Delta River	Stocked lakes/ponds	Other	Total
1997	77	51	196	0	127	279	730
1998	50	21	320	0	105	174	670
1977-81	Na <sup>d</sup>	295	628	na	na	680	1,201
1982-86	24	258	1,322	234	24	376	2,368
1987-91	90	233	328	40	527	305	1,536
1992-96	139	116	337	3	386	204	1,211
1977-1998	100	189	632	34	332	376	1,499
Catch <sup>a</sup>							
1997	245	245	1,466	0	402	959	3,317
1998	351	341	1,349	0	765	789	3,595
1994-98	338	301	1,466	12	801	834	3,808
1990-98	331	432	1,444	34	897	1,072	4,190

<sup>a</sup> Information available from 1990-1997 only. Anglers may have harvested or released fish tallied as "catch."

<sup>b</sup> Includes Tangle River.

<sup>c</sup> Mills 1978-1994, Howe et al. 1995-1999.

<sup>d</sup> No reported Harvest.

Based upon observation of spawning lake trout in the fall, the spawning population could be less than 300 fish. Female lake trout in Fielding Lake reach sexual maturity at an average age of eight years old and at an average length of 21 inches (Burr 1991). An increase in the minimum size limit to 24 inches would allow more lake trout to spawn before being harvested.

Stocking of lake trout into small roadside lakes in the Tanana drainage has been successful in higher elevation lakes and has added diversity to the stocking program. Lakes stocked along the Meadows Road and Coal Mine Road, South of Delta Junction, and 4-mile lake along the Taylor Highway, have healthy populations of lake trout. Estimated harvest in 1998 of lake trout from stocked lakes was 16% the total lake trout harvest in the Tanana drainage (Table 14).

## **FISHERY OUTLOOK**

In 1998, a three-year research project was begun in Fielding Lake to estimate the population of lake trout. In September of 1998 and 1999, 96 and 92 fish respectively were captured with a seine on the only spawning bed observed. The recapture rate of males was 70%, and the total population was likely less than 300 fish.

In Sevenmile Lake a lake trout egg-take was conducted in 1999 as well as a mark-recapture experiment to determine if initial egg take removal in 1993 is having an effect on the population. In 1999, a total of 69 female and 69 male lake trout were fully spawned (using the air spawning technique). Eggs from three ripe females (approximately 3,800 eggs) were seeded into artificial incubators and placed back into Sevenmile Lake, the rest of the eggs were sent to Ft. Richardson via State pickup truck after water hardening. The eggs were counted (approximately 83,000) and seeded into one Heath stack incubator (15 trays).

## **BOARD OF FISHERY ACTIONS**

The Board of Fisheries approved restrictive bag limits throughout the Tanana River drainage in 1987 which restricted the daily bag and possession limit to two fish per day with no size limit. These regulations required lake trout harvested in Fielding and Tangle lakes to equal or exceed 18 inches in total length. Additionally, Tangle Lakes harvest was reduced to one fish per day and in possession, and a minimum length limit of 18 inches. On July 1, 1993, the minimum size limit was changed by emergency regulation from 18 to 22 inches on Fielding Lake and a length limit of 18 inches was established for Harding Lake. This regulation was effective in reducing the harvest in Fielding Lake from 276 in 1993, to an average of 41 from 1994-1998 (Table 14). No formal board action has supported emergency orders.

## **CURRENT ISSUES**

It was decided that no brood source for the lake trout stocking program would be accepted from outside the drainage because of genetics and disease considerations. The lake trout population at Sevenmile Lake was identified as a suitable brood source for the stocking program in 1992. During 1993 (1995, 1997 and 1999), Sport Fish Division conducted a live-spawning egg-take from lake trout in Sevenmile Lake. An egg take of 107,000 eggs in 1993 constituted a minimum of 20% of the annual egg production of the population (Burr 1994). Egg removal from the lake every other year instead of every

year will lessen the impact upon long-term production. In 1995, 1997 and 1999, 63,100 (Taube 1996), 84,000 and 83,000 (D. Bee, Dept. of Fish and Game, hatchery, personal communication) eggs were taken. It is not clear how egg loss will impact the population. Future periodic monitoring of the population will help managers to decide if egg-takes should continue.

More anglers are discovering the single spawning bed at Fielding Lake. Other lakes such as Round Tangle Lake have a single spawning area and are susceptible to exploitation (J. Burr, Alaska Dept. of Fish and Game, personal communication). Populations with single spawning locations within a lake may need protection during spawning when they are extremely susceptible to fishing.

### **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

In 2000 an estimate of the lake trout abundance, survival and recruitment in Fielding Lake will be concluded. Preliminary observations indicate a small population, as anticipated. Due to low abundance, a proposal will be submitted to the BOF to increase the minimum length limit and close the fishery during the spawning season. Future research should be directed at obtaining an estimate of the spawner population at Tangle Lake.

## **SECTION VI: TANANA RIVER BURBOT**

### **BACKGROUND AND HISTORICAL PERSPECTIVE**

People residing within the Delta area are the primary participants in this year-round fishery. Most fishing occurs during spring and summer in the upper Tanana River drainage, unlike the winter fishery in the Fairbanks area. In past years, the most heavily fished lakes were Fielding, Harding, and Tangle lakes. Since 1987, bag limits in these lakes were reduced to two fish daily, and the use of setlines was eliminated. Burbot stocks in the Tanana River are exploited most heavily near population centers such as Fairbanks, Delta Junction, and near Northway. Burbot movements within the Tanana River tend to minimize effects of concentrated local fishing effort, and stocks in the Tanana River appear to be lightly exploited (Evenson 1997).

### **RECENT FISHERY PERFORMANCE**

The 1998 estimated harvest of burbot in the Tanana River drainage by sport anglers was 3,295 in 1998, about 1,300 fish below the 22-year average (Table 15). In 1998, 54% of the burbot harvest came from the Tanana River. The Tanana River is split into three statistical areas; Lower, middle, and upper Tanana River. In 1998, no burbot were caught in the lower section, 1,448 caught in the middle section and 465 in the upper section (Howe et al. 1999). The middle section includes the Fairbanks and Delta areas. It was estimated based on the relative size of the respective fisheries that about 70% of the burbot harvest is taken in the Fairbanks area while 30% occurs in the Delta area, (Parker and Viavant 2000). In 1998, the burbot harvest in the Delta area was 1,193 or 36% of the total burbot harvest in the Tanana River (Table 6).

Harvest from area lakes has declined since 1987 when restrictions on number of hooks, set lines, and seasons for many lakes were enacted. From 1981 to 1984, harvests of burbot at Fielding Lake averaged 330 per year, which resulted in a crash of the adult

**Table 15.- Sport harvest and catch of burbot in the Tanana River drainage<sup>a</sup>.**

Year	Fielding Lake	Tangle Lake <sup>b</sup>	George Lake	Shaw Creek	Tanana River	Other	Fairbanks Waters <sup>c</sup>	Total
1997	0	42	52	0	2,193	240	1,198	3,725
1998	0	0	8	71	1,792	410	1,014	3,295
Averages								
1977-1981	249	146	46	NR	NR	1,234	934	2,609
1982-1986	255	80	83	237	2,214	1,109	1,935	5,913
1977-1986	253	109	69	237	2,214	1,171	1,683	5,737
1987-1991	25	20	22	294	2,095	541	827	3,823
1992-1996	31	12	85	116	2,478	423	1,174	4,319
1977-1998	94	63	61	181	2,232	781	1,226	4,638
Catch <sup>d</sup>								
1997	0	42	73	0	3,138	635	1,408	5,296
1998	25	0	8	79	2,630	537	1,312	4,591
1990-1998	26	30	67	172	2,829	663	1,356	5,143
1994-1998	20	29	75	91	3,152	565	1,275	5,205

<sup>a</sup> Information available from 1990-1998 only. Anglers have harvested or released fish tallied as "Catch".

<sup>b</sup> Includes Tangle River.

<sup>c</sup> Fairbanks waters include Harding Lake, Chatanika River, Chena River, Minto Lake and Tolovana River, Piledriver Slough, and Nenana River.

<sup>d</sup> Mills 1978-1994, Howe et al. 1995-1999.

NR- is no harvest or catch reported.

population. Due to low recruitment a cycle of high and low abundance has occurred thereafter (Parker 1999). In 1994 the department issued an EO to close the taking of burbot until further notice. Only recently has the population stabilized and in the future there may be opportunity to fish burbot in Fielding Lake (Parker 1999). The only reported harvest in 1998 from a lake population of burbot is George Lake. In this lake, most captured fish are harvested (Table 15).

## **MANAGEMENT OBJECTIVES**

For the Tanana River and Tanana drainage lakes, the management objective is to ensure harvest and incidental mortality of burbot are less than 10% of the population size. Therefore, many lake burbot populations have very restrictive regulations to prevent overharvest.

## **FISHERY MANAGEMENT**

Stock assessment of lake-dwelling burbot has occurred in Fielding Lake (Parker 1999). Even though harvest of burbot was not reported in 1998 for other lakes in the Delta area, some low-level harvest occurs by individuals living in the vicinity. Sustainable harvest in small high elevation lakes such as Fielding and Tangle lakes is thought to be low, but if harvest should reach 100 fish per year, impacts upon the population should be investigated.

## **FISHERY OUTLOOK**

Abundance and an index of abundance have been estimated for burbot in Fielding Lake since 1995. In 1998, estimated abundance of fully recruited burbot ( $> 450$  mm TL) was 421 (SE = 42). When the population exceeds 500, consumptive harvest may be allowed.

## **BOARD OF FISHERY ACTIONS**

No regulatory matters for Tanana drainage burbot were brought before the Board of Fish during the 1997 cycle.

## **CURRENT ISSUES**

Exploitation rates of burbot in the Tanana River are not considered excessive. However, low abundance in most lakes may result in over-exploitation. Burbot stock assessments carried out by ADF&G during the late 1980's indicated that the uppermost Tanana River section near Northway supported the lowest density of large burbot among the river sections sampled (~90/km sampled, Evenson 1991). Subsistence and personal-use fisheries for burbot are known to occur in the upper Tanana, but harvest in these fisheries has not been estimated. Although fisheries occur throughout the year, the major effort for burbot is in the spring prior to a rise in water levels caused by glacier melt. Current estimates of stock status or of harvest do not exist for the upper Tanana drainage. However, this part of the river has had low abundance of burbot when compared to other sections of the river and has seasonally intense effort and harvest. Therefore, there is concern for locally depleted population of the junction of the Nebesna and Chisana rivers.

Population density of burbot in lakes declined dramatically in the early 1980's due to unsustainable rates of harvest. Stock assessment studies in the 1980's conducted in lakes of the upper Susitna/upper Copper River basin and the Tanana River drainage (Lafferty et al. 1992), confirmed that several lake stocks in the Tanana drainage showed evidence of high exploitation. More recent stock assessment studies conducted in lakes of the Tanana River drainage demonstrate the detrimental population effects of long-term high exploitation rates (Parker 1999).

## **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

Ongoing population assessment of burbot in Fielding Lake is a long-term project to determine the effects of overharvest on the population. The Tanana River burbot population near Northway area should be investigated because of seasonal depletion. Since the Department is unaware of what kind of fishery occurs on this resource, an attempt to estimate harvest from all fisheries of burbot is recommended.

## **SECTION VII: DELTA AREA NORTHERN PIKE**

### **BACKGROUND AND HISTORICAL PERSPECTIVE**

The major northern pike sport fisheries for the Delta Area occur in George, Volkmar and Healy lakes, and also the Goodpaster and Volkmar rivers. There are several lakes and creeks in the Tetlin National Wildlife Refuge that also have abundant pike resources but do not show up in the SWHS. There are no road accessible pike fisheries in the Delta area, and with the exception of Scottie and Moose creeks and Deadman Lake near the Canadian Boarder, all are accessed by plane or boat, and are mostly open-water fisheries. Other lakes in the Delta Area with pike populations are Sand, "T", Mansfield, Dog, Island, Tetlin, Takomahto, Jatahmund, Island, and Wellesley lakes. George Lake, the largest pike fishery in the Delta Area, is accessed by boat, snowmachine, and float and ski equipped airplane, and the fishery occurs year round. Volkmar Lake is accessed primarily by snowmachine, but also by float and ski equipped airplane, and the fishery there occurs primarily in the winter.

Much of the effort directed towards pike in the Tanana drainage is non-consumptive. Pike harvest in 1998 represented 14.5% of the total fish harvest in the Tanana drainage (Table 6). Although effort is not estimated by target species, it is felt that the majority of the effort at George and Volkmar lakes is directed toward northern pike. Lately, effort at George and Volkmar lakes has been more variable, particularly at George Lake. Access to these lakes has been prevented by low snowfall and low creek levels.

Stock assessment of northern pike populations in the Tanana drainage has been done during various years between 1987 and 1994. Assessments were done at George Lake in from 1987 through 1991 and at Volkmar Lake from 1985 through 1994.

Anglers use hook-and-line gear all year to harvest northern pike. In addition, spears are used during the ice-cover months. Anglers fishing in lakes are very successful in the spring when pike have concentrated for spawning (Hallberg 1992). In 1993, 549 households responded to a northern pike survey to gather information on the distribution of participation, harvest and kinds of gear used by successful pike anglers. Results showed that 84% of participation and 82% of the harvest occur in the open-water months (Bingham and Parker, 1995). Open-water fishing participation occurred slightly more on rivers (51%) than on lakes (49%).

Only 14% of the total participation occurred during the ice-covered season, of which 86% of effort was on lakes. Anglers harvested 40% of their pike using spears, which are more effective than using hand-held lines or tip-up's. Anglers reported that a small spearhead, less than 6 inches in width, may not be as efficient in harvesting pike as a spear head that is 6-10 inches (Bingham and Parker, 1995).

## **RECENT FISHERY PERFORMANCE**

Estimated harvests for northern pike fisheries in the Tanana drainage have been highly variable over time at most locations (Table 16). However, there is a declining trend in the overall harvest over the past five years (Table 16). Anglers would likely take more advantage of the fishery at George Lake if access improved. In recent years low creek levels and snowfall have made it difficult to boat into the lake in the open water months and snowmachine during the winter. George Lake supported harvests that were consistently over 1,000 fish up until the late 1980s, but since then have ranged from 460 to 1,100 (Table 16).

Volkmar Lake is a remote lake, only accessible by floatplane during the open water months. The majority of the effort occurs during the winter when anglers access the lake by snowmachine from Quartz Lake to the Goodpaster River, or by crossing the Tanana River from Sawmill Creek Road, east of Delta Junction. During the winter the fishery is characterized as consumptive. Fish caught by jigging or spearing are easily preserved by freezing. A recent access improvement to the Sawmill Creek Road trail has increased recreational activity at Volkmar Lake. Anglers reported drastic declines in the pike population in Volkmar Lake that prompted a reduction in the bag and possession limit to one fish per day during the last BOF meeting.

## **MANAGEMENT OBJECTIVES**

The department spent 10 years conducting population surveys on Volkmar Lake from 1985 to 1994. According to sustained yield models, the Volkmar Lake maximum production level population is 3,000 fish (catchables > 18 inches). The average abundance of catchable pike is 2,800. Based upon the average population size, an annual harvest between 10-20% (or 300-550 fish) is sustainable.

During late 1997 the BOF reduced the bag and possession limit to one fish with no size limit. Anglers from Delta Junction testified that effort in 1996 was high but harvest was poor, with few large fish. No estimates of harvest were available for 1996 because too few Volkmar Lake anglers responded to the SWHS. The department saw no decline in the number of icehouse permits issued in 1996 (as a gauge of effort) and supported the bag reduction proposed by a local angler as a conservation measure. The department feels that the reduction of the bag limit is sufficient (harvest of 84 in 1997, Table 16) to reduce effort and harvest to acceptable levels.

Pike fisheries (except for the Chena River) are managed under a set of management plans written and adopted between 1992 and 1993. The objectives in these management plans include ensuring that northern pike harvests and incidental mortality from the recreational fishery are sustainable and benefits to the public derived from the recreational fisheries outweigh the costs of managing the fishery. These plans also include objectives regarding the level of participation in each fishery.

**Table 16.-Sport harvest and catch of northern pike in the Tanana River drainage<sup>a</sup>.**

	Harding	Chena	George	Volkmar	Minto		
Year	Lake	River	Lake	Lake	Lake	Other	Total
<b>Harvest:</b>							
1994	539	236	948	206	8,438	3,471	16,299
1995	502	500	531	1084	3,126	1,532	10,620
1996	363	407	1069	Na <sup>b</sup>	1,278	1,349	6,618
1997	94	206	462	84	1,702	1,527	5,016
1998	271	364	603	Na	1,106	1,607	4,404
1994-1998	354	343	723	458	3,500	1,742	8,591
1977-1998	803	557	1,381	417	2,934	2,263	8,984
<b>Catch:</b>							
1994	5,559	1,092	4,377	1,928	47,248	14,707	88,702
1995	3,852	1,890	1,582	1,801	21,823	7,858	53,963
1996	4,070	1,624	3,687	Na	12,495	11,873	43,279
1997	2,578	1,762	2,966	598	14,712	7,995	36,221
1998	3,051	1,821	4,987	Na	6,854	11,091	31,057
1994-1998	3,822	1,638	3,520	1,442	20,630	10,705	50,644
1990-1998	4,139	1,751	3,558	1,171	15,620	11,414	44,920

<sup>a</sup> Howe et al. 1995-1999.

<sup>b</sup> Data not available.

## **FISHERY MANAGEMENT**

Estimates of catch and harvest from the SWHS for Volkmar Lake are periodic, with only six estimates in 21 years. From 1981 to 1998 there was an average of 417 angler days (Table 16) per year. Harvest of northern pike in Volkmar Lake appeared to be sustainable up until 1994 (Parker and Viavant 2000). About 3,100 spawner-sized fish (>449 mm) were estimated in the spring of 1993 (Pearse 1994). In 1992, the harvest was 231 fish resulting in an exploitation rate of 7%. In 1994, abundance was 2,300 over 449 mm (Hansen and Pearse, 1995) and the exploitation rate was 14% based on an estimate of 320 fish harvested in 1993. A sustainable harvest for a population of 2,000 spawners is about 300 pike. Therefore, in 1994 the population was slightly above the maximum sustainable level and harvest, (Hansen and Pearse 1995). However, the harvest of 1,084 northern pike in 1995 is not sustainable and may have been responsible for the population decline experienced by anglers in 1996 and 1997. The harvest rate per angler-day is 0.9 for Volkmar Lake, which allows 330-550 sustainable angler-days. At these harvest rates, it is unreasonable to provide 1,000 angler-days, which is called for in the management plan without increasing restrictions. Improved access is blamed for the recent increase in effort. In February 1994, there were 12 icehouses on the lake (most ever recorded) and many reports to staff of increased fishing use. For management purposes, an estimate of over 600 angler-days should be of concern.

## **FISHERY OUTLOOK**

Abundance of northern pike in Volkmar Lake will be estimated for summer of 2000 and will be available for deliberations at the BOF meeting that December. The population in George Lake is thought to be healthy. Effort and harvest have been down in recent years due to difficulty in accessing the lake.

## **BOARD OF FISHERY ACTIONS**

Due to unsustainable harvests and population declines in some fisheries, regulations for pike were restricted during the late 1980s. In 1987, the bag limit was reduced from ten per day to five per day, and only one fish > 30 inches. In 1992, the Board of Fisheries passed a regulation that established a spring spawning closure (April 1- May 31) in the Tanana drainage. The closure was intended to protect northern pike while they are concentrated for spawning and most vulnerable to anglers (Arvey 1995).

Several proposals relating to northern pike in the Tanana drainage were considered by the Board of Fisheries during the 1997 AYK meeting. The Board adopted the Departments proposal (191) to remove the area-wide spring spawning closure for flowing waters (except the Tolovana drainage) and relaxed the drainage-wide spawning closure by beginning the spring closure April 21 rather than April 1, with the exception of popular fisheries such as Harding, George (including its outlet), and Volkmar lakes. The Board adopted a public proposal (supported by the department) to reduce the bag and possession limit at Volkmar Lake from five to one fish per day (proposal 192), but amended the proposal to continue to allow spear fishing (originally proposed to ban spear fishing).

## **CURRENT ISSUES**

The public would like ADF&G to increase the number of large fish in Volkmar Lake. Ten trophy sized northern pike have been taken from Volkmar Lake since the inception of the ADF&G trophy program. Currently, anglers on average harvest 60% of the population > 30

inches. The average proportion of pike (> 30 inches) harvested since 1991 is 28% and 97% of captured pike > 30 inches caught are harvested. To increase the proportion of large fish captured, more medium sized pike must be allowed to recruit. A maximum size limit of 26 inches or a slot limit up to 26 inches and over 40 inches may accomplish this objective. Anglers must concede to harvesting fewer large fish. Also, spearing as a method would likely be incompatible with a slot limit. After evaluating the population in 2000, staff can make a recommendation for a particular harvest regulations.

### **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

A population study of northern pike in Volkmar Lake is necessary to determine the effects of perceived overharvest. This information will be conveyed to the BOF as updated information.

## **SECTION VIII: DELTA AREA STOCKED WATERS**

### **BACKGROUND AND HISTORICAL PERSPECTIVE**

The Alaska Department of Fish and Game (ADF&G) stocks game fish in 45 lakes in the Delta Area. The stocking program is designed to provide additional fishing opportunities near communities and popular recreational destinations where fish resources and angling opportunity are limited and where fishing effort and harvest are highest. Lakes in the stocking program range in size from a few acres to several hundred acres and are accessible by road, trail, ATV or aircraft. Most of the fisheries are year-round and considerable angling effort occurs during the winter on some lakes. The stocking program also generates an important conservation benefit because it diverts harvest away from wild populations.

In 1998, an estimated 17,230 anglers fished in the Delta area and they generated an estimated 44,313 angler-days of effort. About 16,215 angler-days of effort were directed toward stocked fish in Delta area lakes (Table 17; Figure 8). The harvest and catch in these stocked lakes were estimated at 31,566 and 76,670 fish (Table 17). Since 1990, stocked fish in the Delta area represent 22% to 40% of the estimated annual harvest, 12% to 18% of the estimated annual catch, and 9% to 18% of the estimated fishing effort in both the upper and lower Tanana drainages.

Today ADF&G provides diverse year-round sport fishing in the Delta area for rainbow trout, coho salmon, Arctic grayling, Arctic char, and lake trout. Goals of the fish-stocking program in Region III are:

1. Reduce harvest pressure on wild stocks;
2. Provide angling opportunity for increasing numbers of anglers;
3. Diversify angling opportunity (species, location, and access); and,
4. Rehabilitate depleted wild stocks.

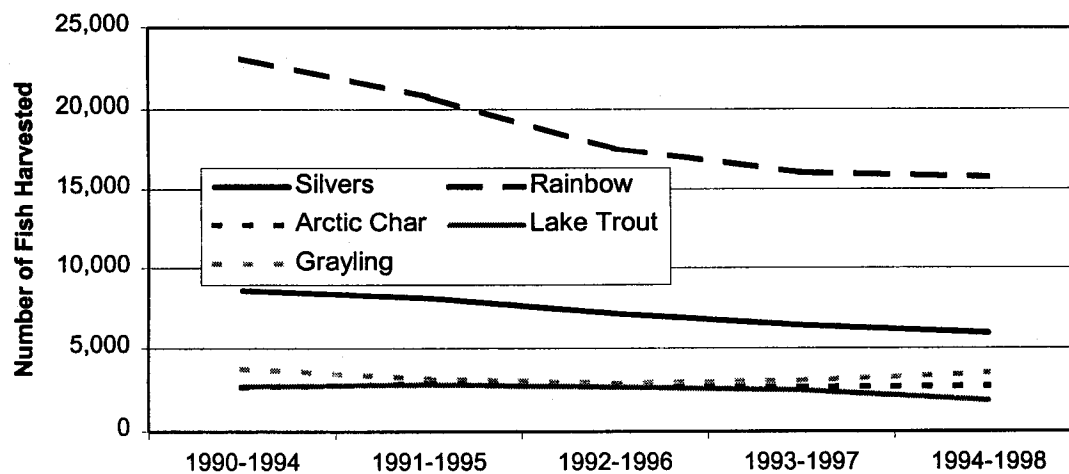
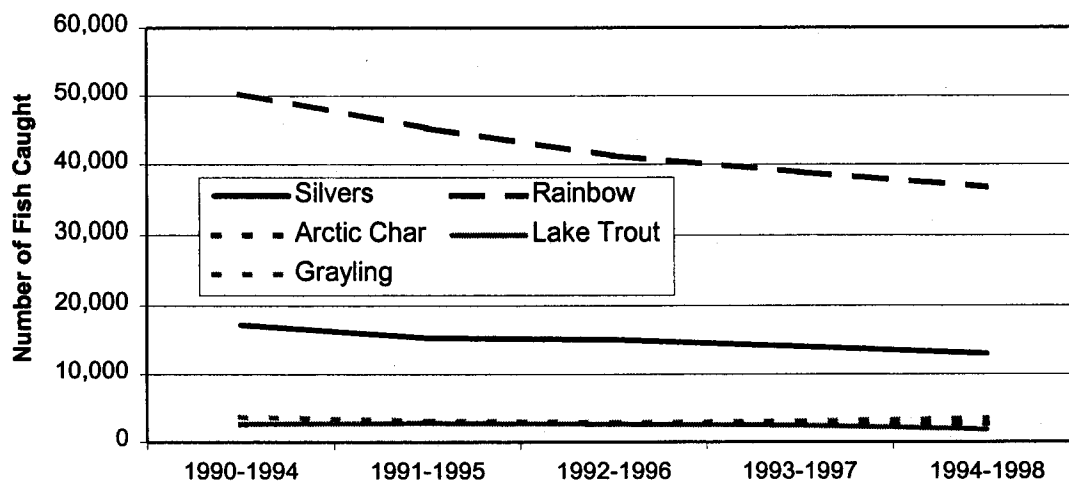
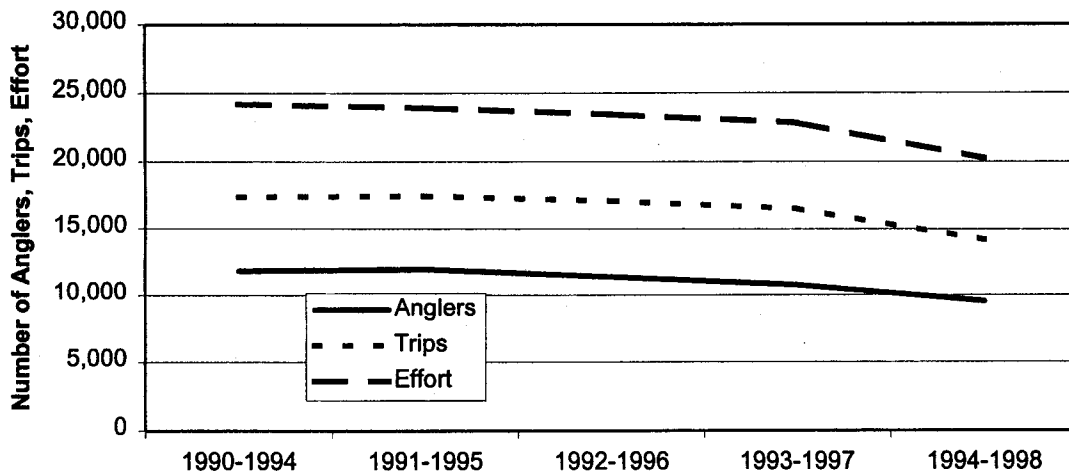
Meeting public demand for recreational fishing opportunities in Alaska while at the same time maintaining and protecting the wild fishery resources has become increasingly complex. Today, Alaska is experiencing increased tourism and continued forest, mineral,

**Table 17.-Summary of fishery statistics for stocked waters in the Delta area, 1990-1998.**

	Objective	1990	1991	1992	1993	1994	1995	1996	1997	1998
Days fished (effort)	15,000	26,892	23,091	18,432	29,038	23,441	25,535	20,625	15,332	16,215
Harvest		37,187	47,624	25,176	34,945	24,523	22,914	23,408	13,796	26,377
Catch		90,097	79,162	56,690	90,338	56,810	53,736	54,165	38,695	75,264
Mean catch rate (catch / effort)		2.4	1.7	2.3	2.6	2.3	2.3	2.3	2.8	2.9
Stocking cost <sup>a</sup>		\$43,984	\$74,895	\$48,551	\$100,760	\$47,472	\$92,166	\$79,523	\$53,215	\$39,153
Cost-per-day of fishing		\$1.64	\$3.24	\$2.63	\$3.47	\$2.03	\$3.61	\$3.86	\$3.47	\$2.41
Management & Research cost										\$69,496
Cost/Benefit <sup>b</sup> (wo/Mgt&Res cost)									\$1.38	\$0.52
Cost/Benefit <sup>b</sup> (w/Mgt&Res cost)										\$1.44

<sup>a</sup> The method used to calculate annual stocking costs changed in 1998. Prior to 1998, stocking costs included only costs directly associated with hatchery operations. Not included were costs for statewide hatchery supervision and eggtakes or regional management, research, and support activities. Stocking costs in 1998 include the costs of hatchery operations, regional hatchery supervision, and eggtakes. Listed separately are regional management and research costs.

<sup>b</sup> Cost/Benefit is calculate as Stocking Cost / Catch.



**Figure 8.-Five-year angler effort, catches and harvest averages for Delta area stocked water fisheries.**

and petroleum development. A growing avid recreation-oriented population accompanies this growing economy. Accessible sport fisheries have become crowded, new fisheries have developed, and pressure from a large mobile population is spilling ever farther afield.

Stocking serves to divert angling pressure away from fragile wild stocks and maintain angling opportunities. Consequently, stocking has become a vital component of the statewide sport fish program.

Recreational fish stocking is funded primarily by two sources. One is the Sport Fish Account of the state Fish and Game fund, which includes revenues from sales of fishing licenses. The second, and larger funding component, is the Federal Aid in Sport Fisheries Restoration program, comprised of the Dingell Johnson (D-J) Fund and the Wallop-Breaux Amendment (W-B).

## **RECENT FISHERY PERFORMANCE**

From 1990 to 1998, the five-year moving average of fishing effort on 45 stocked lakes in the Delta management area has ranged from 20,000 to 25,000 angler days (Table 17 and Figure 4). For the same period, the five-year averages for catch have ranged from 37,000 to 51,000 fish and harvests have ranged from 16,000 to 24,000 fish. Almost 80% of fishing effort occurs on Quartz Lake. More than half the catch and harvest in the Delta area is comprised of rainbow trout (Table 18). ADF&G will continue to stock lakes that provide fishing opportunities and where stocked fish exhibit good survival and growth. We will evaluate new lakes as candidates in the stocking program based on public requests for new fisheries.

In 1988, the cost of the stocking program for the Delta area was about \$70,000 (Table 17). The method used to calculate program costs was modified in 1998 to include costs associated with statewide hatchery management and supervision, regional management, research and support activities. The department has continued to make hatchery and stocking operations more efficient and has actually reduced stocking costs. The cost per angler-day in 1988 was about \$2.41 while the cost per fish caught was about \$1.44 (Table 17).

## **MANAGEMENT OBJECTIVES**

### **Quartz Lake**

In 1998, the stocked waters in the Delta area were classified into major (>5,000 angler-days of effort) and small fisheries. Quartz Lake is the only major fishery. All other lakes are collectively called small stocked lakes.

The stocking program at Quartz Lake provides roadside angling opportunity for residents and visitors. Stocking of a variety of sport fish species provides species diversity attractive to anglers. Availability of stocked salmonids in roadside lakes creates year-round fishing opportunity otherwise unavailable in Interior Alaska. Tanana Valley residents surveyed by ADF&G in 1985 and in 1988 indicated that about 80% of the respondents approved of stocking fish as a means to improve fishing.

Effort that might otherwise be directed toward Tanana drainage wild stocks vulnerable to over-fishing is absorbed at Quartz Lake and other stocked lakes. Increasingly restrictive regulations have been implemented to protect wild stocks in interior Alaska. As fishing

**Table 18.-Effort, harvest, and catch statistics for stocked fisheries in the Delta area 1990-1998.**

	1990	1991	1992	1993	1994	1995	1996	1997	1998
<b>Effort</b>									
Number of Anglers	12,307	12,556	10,769	12,388	11,115	12,935	9,653	7,682	6,220
Number of Trips	17,870	15,580	13,905	21,134	18,308	18,269	13,735	11,116	9,484
Number of Days Fished (effort)	26,892	23,091	18,432	29,038	23,441	25,535	20,625	15,332	16,215
<b>Catch</b>									
Silvers	20,425	17,019	15,144	20,887	12,865	10,935	15,597	10,063	15,704
Rainbow	64,135	53,493	38,191	60,201	35,387	39,168	33,270	26,181	49,163
Arctic Char	1,563	3,691	1,712	3,912	2,365	2,643	2,780	1,603	4,237
Lake Trout	1,208	2,472	2,521	4,447	2,881	1,737	1,714	1,541	1,412
Grayling	4,456	4,324	888	3,846	5,289	1,437	3,046	1,607	6,155
Total Fish	91,787	80,998	58,455	93,291	58,786	55,919	56,407	40,994	76,670
<b>Harvest</b>									
Silvers	7,377	11,575	7,205	10,056	6,723	4,910	6,724	3,598	7,644
Rainbow	28,257	31,622	17,242	23,022	15,375	16,609	15,487	9,675	21,596
Arctic Char	272	2,136	487	1,186	627	1,024	893	397	1,801
Lake Trout	456	1,070	443	1,108	1,160	469	258	364	361
Grayling	1,283	2,231	343	353	1,162	440	381	172	165
Total Fish	37,644	48,634	25,719	35,724	25,045	23,452	23,743	14,205	31,566

and harvest pressures upon these stocks have increased, stocking of hatchery fish has become an increasingly effective management option for meeting the demand for recreational fishing opportunities in the Tanana drainage. ADF&G questionnaires sent to license holders in the Tanana drainage shows anglers target Arctic grayling (wild stocks) more than other species. Rainbow trout are the second most commonly targeted species. However, surveys in 1980, 1985, and 1988 indicated that the proportion of anglers fishing specifically for rainbow trout has increased, but the proportion of anglers targeting Arctic grayling has decreased.

Quartz Lake supports both a winter ice fishery and an open-water fishery. Creel surveys conducted by ADF&G indicate that about half of the annual fishing effort occurs during the open water period (May through September) and the other half occurs when the lake is covered with ice (October through April). Recent 5-year averages have ranged between 13,500 and 16,100 angler-days of effort, from 38,500 to 54,300 fish caught, and from 17,000 to 26,600 fish harvested. The average catch rate for the last five years is about three fish per angler day.

Specific objectives for Quartz Lake:

- Provide 20,000 annual angler days or more of sport fishing effort.
- Provide diverse sport angling opportunities through the annual or alternate year stocking of rainbow trout, coho salmon and Arctic char (Table 17).
- Maintain an annual mean catch rate in excess of two sport fish per angler day while allowing anglers to keep the portion of their catch, if they so desire.

To provide for the above objective the department will annually stock 30,000 fingerling Arctic char, 80,000 fingerling coho salmon and 400,000 fingerling rainbow trout. Performance of the fishery will be evaluated using sport fishing effort and harvest estimate through the Statewide Harvest Survey and status of stocking cohorts evaluated through on-site creel surveys and/or field sampling.

### **Small Lakes**

The small lakes stocking program was intended to provide additional fishing opportunities by increasing the diversity of sport species and fishing experiences available to anglers. Year-round fishing opportunities were created in waters ranging from urban ponds located within or near communities to remote lakes and ponds that were only accessible by trail and by aircraft.

The stocking program has provided alternative opportunities for anglers that might otherwise direct their efforts toward native species of sport fish that are vulnerable to over-fishing. Increasing sport fishing pressure and over-harvest of several species of indigenous fish during the early and mid-1980's resulted in more restrictive regulations in several fisheries of interior Alaska. As harvest pressure has increased, stocking of hatchery fish has become an increasingly important management tool to meet the demand for recreational fishing opportunities in the Tanana drainage.

Since 1990, the five-year moving average for fishing effort in these lakes has ranged from about 19,000 to more than 24,000 angler-days. In order to maintain effort at or above the goal of 20,000 angler days, lakes with the greatest potential for increased fishing effort were emphasized. Lakes with the greatest potential include those near population centers, those that are road accessible, and those that are large.

Urban lakes were stocked annually. Most of the stocked fish were of catchable size (8 inches or greater). Catchable-sized fish were stocked as soon as the ice was gone, to accommodate angler enthusiasm for spring fishing.

In 1994, an attempt began to manage two lakes, (Craig and Coal Mine #5) for large rainbow trout utilized primarily in a catch-and-release fishery. Winter fishing has been closed, gear restricted to single-hook unbaited flies or lures, and the bag limit reset at one fish over 18 inches.

Specific objectives for small stocked lakes:

- Manage important native populations of fish according to sustained yield principles.
- Provide a combined 20,000 days of sport fishing effort (angler-days) for both upper and lower Tanana drainage lakes.
- Provide sport angling diversity through annual or alternate year stocking of multiple species of sport fish.
- Publicize the fishing opportunities available to anglers.
- Improve public access where needed.
- Manage three small stocked lakes (Craig Lake and Coal Mine #5) to provide catch-and-release, and/or limited harvest opportunities for larger than average rainbow trout.

The above objectives for small stocked lakes (Appendix Table A2) will be evaluated using the sport fishing effort and harvest estimates in the Statewide Harvest Survey. Stocking cohort status may be assessed by periodic on-site sampling, or as a component of research projects.

## **FISHERY MANAGEMENT**

The Division of Sport Fish strategy is to stock species most suited to a particular lake's physical characteristics and at a size to account for lake productivity and harvest pressure. Rainbow trout and Arctic grayling do well in most of our lakes and support our summer fisheries. Coho salmon also do well in most lakes and provide an aggressive fish during winter when other species are less active. Arctic char and lake trout are long lived and grow to large size that makes them attractive to anglers. In some lakes more than one species are stocked to provide diversity and to take advantage of different seasonal behavior. Rainbow trout and coho salmon are the most popular combination.

The state hatcheries are able to provide us with different size fish from sac-fry (1 inch) to catchables (6-10 inches), and even excess brood stock (12-18 inches). Because lakes have different capabilities for producing catchable fish, ADF&G requests different size fish to meet certain stocking objectives. Fingerling rainbow trout and coho salmon are stocked in Quartz Lake because the lake produces sufficient numbers of catchable fish from fingerling stockings. In small roadside lakes like Little Lost Lake, Rich 81, and J Lake, ADF&G stocked catchable rainbow trout and Arctic grayling. These lakes are small and receive a lot of fishing pressure relative to their size. As a result, they can't produce sufficient numbers of catchable fish (from stockings of fingerlings) to meet angler demand. The department also stocked some of the high use lakes early in the spring and again one or more times during the summer to provide sufficient numbers of fish through the year. Prior to stocking strategy, anglers had expressed frustration with these fisheries because there were few large fish by spring.

ADF&G generally stocked the remote and larger rural lakes with fingerlings because smaller fish are easier and less expensive to transport than larger fish. All of these lakes produced sufficient numbers of catchable fish from fingerling stockings to sustain the existing fisheries. Because these lakes are more difficult to reach the level of effort and harvest is less than that for comparable size lakes near the road system. Generally, these lakes produce larger fish and more of them for the same reasons.

Recently, the department started stocking catchable rainbow trout in lakes near Delta that don't usually support fish through winter. By stocking such lakes with catchable size fish ADF&G has created instant and popular fisheries. The department's goal is to stock only enough fish to support the spring and summer fishing season because any fish left in the lake may not survive the winter. This recent change to the stocking program has increased the number of lakes that can be stocked and increased angler opportunity.

### **Stocking Products**

The state fish hatcheries at Ft. Richardson and Elmendorf Air Force Base near Anchorage produce rainbow trout, Arctic grayling, Arctic char, coho and chinook salmon and lake trout. All species except chinook salmon are stocked in the Delta area. Fish are transported by truck to the stocking location or they are transferred to off road vehicles or aircraft for transport to more remote locations.

#### **Rainbow trout**

Rainbow trout is the primary hatchery product used in lake stocking. All rainbow trout are from a captive brood stock maintained at Fort Richardson Hatchery. The brood stock is descended from wild Swanson River rainbow trout. The stocking program uses two genetic types of rainbow trout: 1) mixed sex diploid fish which are normal fish capable of reproduction; and 2) all-female triploid fish which are female fish not capable of reproduction.

The department generally stocks three sizes of rainbow trout. Catchable rainbow trout are 1 year old and are about 6-10 inches. Sub-catchable rainbow trout are 6 months to 1 year old and are 4-6 inches. Fingerling rainbow trout are usually 2 to 4 months old and are 2-3 inches. Rainbow trout fry are less than 2 months old and usually weighed less than a gram.

#### **Arctic Grayling**

All stocked Arctic grayling are from eggs taken from two wild stocks (Tanana River and Moose Lake-Gulkana River). Only the Moose Lake – Gulkana River stock is used for stocking in the Delta area. No captive brood stock is maintained in the hatchery. We produce four sizes of Arctic grayling for stocking. Catchable Arctic grayling are 1 year old and are 6-9 inches. Subcatchable Arctic grayling are 6 months to 1 year old and are between 4-6 inches. Fingerling Arctic grayling are usually 2 to 4 months old and are 2-3 inches. Arctic grayling fry are less than 2 months old and usually weigh less than a gram. Arctic grayling sac-fry are newly hatched and are about 1 inch.

#### **Arctic Char**

All stocked Arctic char are from eggs taken from a wild stock of fish. The brood stock currently used is from the Bristol Bay Area. No captive brood stock is maintained in the hatchery. Due to the difficulty of conducting a wild egg-take and the longevity of this species, eggs are only taken every other year. Generally we stock three sizes of Arctic char. Catchable Arctic char are 1 ½ years old and are 6-10 inches. Subcatchable Arctic char are 6 months old and are 5-7 inches. Fingerling Arctic char are usually 4 to 6 months old and are 4-5 inches.

### **Coho Salmon**

All coho salmon used for lake stocking are from eggs taken from hatchery-produced adults. Brood stock used may vary depending on availability. Two sizes of coho salmon are stocked. Subcatchable coho salmon are 1 year old and are 4-6 inches. Fingerling coho salmon are 2 to 4 months old and are 2-4 inches.

### **Lake Trout**

All lake trout from the hatcheries are from eggs taken from wild stocks. The brood stock currently used is from Seven-mile Lake (Yukon River drainage) near Paxson. No captive brood stock is maintained in the hatchery. Due to the difficulty of conducting a wild egg-take and the longevity of this species, eggs are only taken every other year. Two sizes of lake trout are stocked. Catchable lake trout are 1 ½ years old and weigh an average of 100g. Fingerling lake trout are usually 4 to 6 months old and weigh between 5 and 10g.

### **Egg Takes**

The Region III stocking program currently assists the hatcheries with eggtakes by capturing and holding fish until they are ready for spawning. When Clear Hatchery was closed in 1997 staff in the region office assumed responsibility for conducting eggtakes in the Tanana drainage and the Upper Copper/Susitna drainages. Other assumed responsibilities included locating wild donor stocks, evaluating their population status, and collecting and holding adults until ready for artificial spawning. To fulfill these new responsibilities a new budget separate from other stocked water evaluation work was given to Region III.

The objective for lake trout is to collect 88,000 fertilized eggs (about 84 females) from the lake trout population in Sevenmile Lake. Since 1987, the Alaska Department of Fish and Game (ADF&G) has collected eggs from wild lake trout populations at Paxson Lake and Sevenmile Lake. Eggs were collected in the fall and were incubated at state hatcheries during winter. The progeny were reared at the hatchery for up to one year. These fish were then stocked as fingerlings (4g) up to catchables (100g) in several lakes in the Tanana drainage and Mat-Su area to enhance sport-fishing opportunities. Fertilized eggs collected for the lake-stocking program are now taken every two years from the lake trout population in Sevenmile Lake, which lies in the Tanana River drainage. Lake trout typically spawn at night in large aggregations in shallow water over rock reefs. Known spawning sites are at the south end of the lake. Fertilized eggs are usually taken within a week of capture.

Eighty-four females are required to provide about 88,000 eggs to meet stocking requests for subcatchables (20 g) in 2000 and catchables in 2001 (Table 19). Eighty-four males will be used to fertilize the eggs. Twelve thousand eggs are required for a study to evaluate artificial incubation methods in Sevenmile Lake.

During the year in which an egg-take occurs, about 30% of the total estimated egg production is collected for the stocking program. Because the department now conducts biennial eggtakes only 15% of the total estimated egg production is removed over two years. This is an acceptable level for this population. In 1996, the department estimated about 1,241 lake trout in the population 235 mm and larger. Of these fish 535 were greater than 417 mm. In 1993, the department estimated the lake trout population at 1,426 fish larger than 250 mm.

### **Net-Catch Sampling**

We have numerous requests from anglers for current information on the species and size of fish in our lakes in the Delta area. Anglers use this information to plan fishing trips. Each year we

**Table 19.—Lake trout egg requirement worksheet for Sevenmile Lake.**

Subcatchables needed to stock in 2000 <sup>a</sup>		41,000
Catchables needed to stock in 2001 <sup>a</sup>		5,000
Total fish needed from 1999 egg take		46,000
Survival - egg to subcatchable	~53%	77,652
Survival - egg to catchable	~50%	9,968
Eggs for incubation study in 1999		3,600
Total eggs needed		91,220
Fecundity - eggs/female	1,200	80
Females to spawn		80

<sup>a</sup> Data are modified from the Statewide Stocking Plan for Recreational Fisheries 1997-2001 (Alaska Department of Fish and Game 1997).

attempt to sample the fish populations in four to six lakes in the Delta management area. Most of these lakes are stocked so there is usually no conservation concerns driving the need for information on these fish populations. However, anglers are interested in the species and the size of the fish in these lakes. We use this information to update our *Guide to Stocked Waters*, Internet web site, and informational leaflets. An additional benefit is that biologists are able to observe the fish populations in several lakes and roughly determine their status. From these observations the biologist can judge if a fish population needs further investigation and plan a study to address a specific concern.

### **Lake Mapping and Limnology**

Each year we list a number of lakes that we want to map or inspect. The actual number of lakes that we visit depends on the time available, the priority of other projects and for some lakes if aircraft or ATVs are available. We map lakes to obtain depth data for producing bathymetric maps for anglers and to describe morphology and other lake characteristics for fishery managers. While we are at these lakes we often combine this activity with other activities such as net sampling (described above), water chemistry assays, dissolved oxygen and temperature profiles, and evaluate land-locked status.

### **Statewide Stocking Plan: Region III Update**

The five-year stocking plan for Region III is updated each year in response to public comment, changes in Fishery Management Plans and hatchery production and to comply with current policies. Comments received from the public and current policies are reviewed to determine what changes will be required to update the stocking plan each year. The updated stocking plan for Region III is submitted to Sport Fish Headquarters in November for inclusion into the draft Five Year Statewide Stocking Plan for Recreational Fishing. After a comment period, the finalized plan is usually published and available by 1 February.

### **Fish Transport Permits**

Each fish stocking and egg take requires a Fish Transport Permit (FTP). The Five Year Stocking Plan, regional management plans, and active FTPs are crosschecked prior to stocking or taking eggs to determine if an active FTP exists. Any FTP needed for stocking or for an egg take is submitted for approval. For Region III in 1998-99 we addressed 143 FTP related issues that dealt with changes in hatchery production, brood source, number and size of fish to be stocked, and expiration dates. This required 27 new FTPs and 32 amendments to existing FTPs. A list of active, expired, and pending FTPs is maintained at the Fairbanks office.

### **Hatchery Review**

Fish hatchery management and operational plans for Ft. Richardson and Eielson Air Force Base hatcheries are reviewed to ensure the plans account for the correct number, size, species, brood stock and other special requirements for fish requested through the Five Year Stocking Plan and regional management plans. Requests from the various regions are checked against hatchery production capabilities to determine if requests are feasible. Hatchery and stocking managers discuss options to decrease impact of eggtakes on wild donor stocks and to make the stocking program more efficient. In November 1999 we reviewed the Arctic char and chinook salmon programs.

### **Pamphlets**

Pamphlets about stocked waters in the Delta management area are updated each year with information collected on fish populations such as the species present and their size. Other

information includes recent stocking histories, location and bathymetric maps and available facilities.

## **FISHERY OUTLOOK**

In 1999, a total of 69 female and 69 male lake trout were fully spawned (using the air spawning technique); 16 spawned out and eight green females were also handled. The eggs from three of these ripe females (~3,800 eggs) were fertilized and seeded into Astroturf incubators and placed back into Sevenmile Lake, the rest of the eggs were sent to Ft. Richardson via state pickup truck after water hardening. The eggs were counted (~83,000) and seeded into one Heath stack incubator (15 trays).

In 1998 the department investigated Kenna Lake for future stocking. No fish were observed or captured in gill nets (17 net-hours), fyke nets (16 net-hours), or minnow traps (34 net-hours). There were no defined outlets but there were low areas where water probably seeps out of the lake during years when water levels are high. The department has decided to stock lake trout into Kenna Lake. The donor stock is from Sevenmile Lake that is in the upper Tanana River drainage.

In 1999, ADF&G investigated fish populations in eight lakes in the Delta area. The catch data are summarized in Table 20. The smaller fish in the samples are often fish that were stocked earlier the same year. Finally, Table 21 gives the Sport Fish Division's projected game fish stockings for the Delta Area for 2000-2001.

## **BOARD OF FISHERY ACTIONS**

In 1994, Region III initiated a program to create fisheries for trophy size rainbow trout in Little Harding Lake (22 ha), Craig Lake (7 ha) and Coal Mine #5 Lake (5 ha). Special regulations were adopted by the BOF in 1997 for these lakes to increase the likelihood of creating successful fisheries. These lakes are open to fishing from 15 May through 30 September. Only unbaited, single-hook, artificial lures can be used. The daily bag and possession limit for rainbow trout is one fish which must be > 18 inches (457 mm).

## **CURRENT ISSUES**

Since 1995, the rainbow trout populations in Craig Lake and Coal Mine #5 Lake have been evaluated every year to evaluate progress toward providing trophy fisheries. In Craig Lake and Coal Mine #5 Lake there were fewer and smaller fish than expected. The department tried stocking larger fish in these two lakes but poor results continued. Comparison with length frequency histograms from past years show fish larger than 360 mm were not present in the populations in Craig Lake and Coal Mine #5 Lake. The department suggests that Craig Lake and Coal Mine #5 Lake be dropped from the trophy rainbow trout program.

## **ONGOING AND RECOMMENDED RESEARCH AND MANAGEMENT ACTIVITIES**

In 1994 Region III initiated a program to create fisheries for trophy size rainbow trout in Little Harding Lake (22 ha), Craig Lake (7 ha) and Coal Mine #5 Lake (5 ha). Success in establishing fisheries for trophy rainbow trout in Little Harding Lake, Craig Lake, and Coal Mine #5 Lake had criteria based on size. For these fisheries to be considered successes, at least half of an age cohort must exceed 14 inches (356 mm) by age-4. When stocked these fish were age-1 and averaged 150 to 180 mm. The follow-up study was to estimate the abundance and size structure of the rainbow trout populations in these three lakes. The management objectives for 1998 were

**Table 20.-Summary of stocking activities in the Delta area stocked lakes, 1998-1999.**

Lake	Date	Species	Number	Size Range (inches)	
				Minimum	Maximum
Fourteen Mile Lake	August	Rainbow trout	9	4	12
Backdown Lake	September	Rainbow trout	21	6	13
		Lake trout	25	6	11
Brodie Lake	September	Arctic char	5	9	16
		Arctic grayling	8	6	10
Crystal Lake #1	August	Lake trout	10	14	15
		Arctic grayling	25	5	12
Donnelly Lake	September	Rainbow trout	155	4	13
		Lake trout	76	5	12
North Twin Lake	September	Coho salmon	35	5	18
		Rainbow trout	6	7	17
South Twin Lake	September	Rainbow trout	40	5	15
J Lake	September	Coho salmon	75	6	12
		Rainbow trout	11	10	14
		Arctic grayling	14	8	13

**Table 21.-Summary of projected game fish stockings for Delta area stocked lakes, 2000-2001.**

Number of Lakes 2000/2001	Species	Lifestage	Target Size (in)	2000 Projected	2001 Projected
0/11	Arctic char	Subcatchable	5-6	0	19,725
1/0	Chinook salmon	Catchable	6-10	10,000	0
4/1	Coho salmon	Fingerlings	3-5	95,600	80,000
0/8	Grayling	Catchable	6-10	0	2,650
9/0	Lake trout	Subcatchable	5-6	13,600	0
2/3	Rainbow trout	Broodstock	12-16	50	75
5/7	Rainbow trout	Catchable	6-10	6,300	7,800
8/27	Rainbow trout	Fingerlings	2-5	335,800	439,800

to determine the abundance for each of two age cohorts (age-2 and older than age-2) of rainbow trout in Craig Lake, determine the abundance of one age cohort of rainbow trout in Coal Mine #5 Lake, and determine the abundance of rainbow trout 355 mm and larger in both these lakes.

During the 1998 mark-recapture experiment in Craig Lake, 142 rainbow trout were captured in Event 1 (12 – 15 May) and 38 unmarked and 110 marked rainbow trout were captured in Event 2 (19 – 22 May). The population was estimated at 191 rainbow trout of which four rainbow trout were 350 mm or larger (Table 5). In Coal Mine #5 Lake mark-recapture experiment, 125 rainbow trout were captured and marked in Event 1 (24 - 28 August) and 86 unmarked and 12 marked rainbow trout were captured in Event 2 (8 – 11 September, Table 6). The population abundance was estimated at 959 rainbow trout of which 672 were stocked just prior to conducting the second event. Only 36 fish were 350 mm or larger.

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## **APPENDIX A**

**Appendix A1.-All water reported in State Wide Harvest Survey for the Delta Area portion of the Tanana River drainage in 1998 (Howe et al. 1999).**

Lakes and Ponds	Anglers	Trips	Days	KS	SS	LL	CS	LT	DV/ AC	RT	GR	GR	WFH	WFR	SF	WFO	NP	NP	BB	Other	Total
Quartz Lake	4,911	7,166	12,763	0	0	5,740	0	0	1,200	14,396	0	0	0	0	0	0	0	0	0	0	235
George Lake	569	545	1,006	0	0	0	0	0	0	0	136	10	0	0	0	0	511	92	8	0	31
Fielding Lake	519	572	1,821	0	0	0	0	21	0	0	76	794	0	0	0	0	0	0	0	0	26
Koole Lake	227	246	384	0	0	0	0	0	0	609	0	0	0	0	0	0	0	0	0	0	14
Coal mine road lakes	349	282	629	0	0	0	0	0	204	121	94	0	0	0	0	0	0	0	0	0	16
Craig Lake	67	54	128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Deadman near Canada	73	102	131	0	0	0	0	0	0	0	0	0	0	0	0	0	118	0	0	0	4
Donna Lakes	132	68	171	0	0	0	0	0	0	371	0	0	0	0	0	0	0	0	0	0	3
Eight-mile Lake	8	24	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Fish Lake	16	16	19	0	0	0	0	0	126	0	0	0	0	0	0	0	0	0	0	0	1
Forrest Lake	47	78	102	0	0	0	0	0	0	628	0	0	0	0	0	0	0	0	0	0	5
Four mile (Taylor)	63	258	325	0	0	0	0	0	0	132	17	25	0	0	8	0	17	0	0	0	5
Glacier Lake	24	31	75	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	50	0	1
Healy Lake	187	248	314	0	0	0	0	0	0	0	17	34	0	0	0	0	25	8	8	0	6
Hidden lake near Canada	142	304	365	0	0	0	0	0	101	118	589	294	0	0	0	0	0	0	0	0	8
Jan Lake	114	605	746	0	0	1,161	0	0	0	1,489	0	0	0	0	0	0	0	0	0	0	9
Landmark Gap lake	24	24	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Lisa Lake	32	31	56	0	0	17	0	0	0	84	0	8	0	0	0	0	0	0	0	0	2
Long Lake	21	86	86	0	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	1
Lost Lake (near Quartz)	199	236	418	0	0	0	0	0	193	64	0	0	0	0	0	0	0	0	0	0	11
Mansfield Lake	8	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Meadows Road Lakes	82	242	293	0	0	0	0	8	0	151	0	0	0	0	0	0	0	0	0	0	7
Mineral Lake	71	73	163	0	0	0	0	0	0	0	0	0	0	0	0	0	204	0	0	0	2
Monte Lake	8	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Other Lakes (UTANANA DRAINAGE 50% of the total TANANA DRAINAGE)	377	564	869	0	0	10	0	0	4	796	21	0	0	0	0	0	63	0	34	0	19
Otto Lake	32	22	36	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	3
Ptarmigan Lake	21	29	29	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	1
Rainbow Lake near Delta	24	16	28	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	2
Rainbow lake (same as 255)	48	65	75	0	0	0	0	0	0	303	0	0	0	0	0	0	0	0	0	0	5
Sand Lake	8	8	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Tetlin Lake	24	16	28	0	0	0	0	0	0	0	42	59	0	0	0	0	0	0	0	0	1
Twelve Mile Lake	8	16	19	0	0	0	0	0	0	34	0	0	0	0	0	0	8	8	0	0	1
Twin Lakes (Nabesna Road)	17	15	31	0	0	0	0	0	0	0	21	21	0	0	0	0	0	0	0	0	1

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# Appendix A1.-Page 2 of 2.

Lakes and Ponds	Anglers	Trips	Days	KS	SS	LL	CS	LT	DV/		GR	GR	WFH	WFR	SF	WFO	NP	NP	BB	Other	Total
Volkmar Lake	65	157	224	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	7
Fort Greely ponds	29	133	142	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	2
Weasel Lake (Greely)	8	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Wellesley Lakes	16	8	28	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	1
Delta Clearwater River	1,252	2,778	4,100	0	603	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	67
Goodpaster River	245	369	931	0	0	0	0	0	0	0	197	474	0	0	0	0	0	0	109	0	17
Tangle Lakes and Tangle River	2,826	2,974	5,704	0	0	0	0	320	0	0	1,722	1,390	0	313	0	0	0	0	0	143	129
Shaw Creek	225	280	348	0	0	0	0	0	0	0	0	0	4	29	0	0	26	0	71	0	12
Delta R. (below tangle lakes)	262	189	486	0	0	0	0	0	0	0	119	44	0	0	0	0	0	0	0	0	13
Middle Tanana R. (UTANANA DRAINAGE .30% of total TANANA DRAINAGE)	321	760	1067	0	0	0	5	0	8	0	5	11	0	0	0	6	20	0	398	0	18
Upper Tanana River	288	780	983	6	0	0	0	0	51	0	0	34	0	0	0	0	17	0	465	0	19
Beaver Creek	17	15	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Berry Creek	8	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Boulder Creek	8	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Richardson Clearwater R.	32	8	37	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1
Clear Cr. (Whitestone)	40	39	65	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0	0	3
Clearwater Cr. (Tok)	40	30	54	0	0	0	0	0	0	0	21	56	0	0	0	0	0	0	0	0	3
Desper Creek	24	47	103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Fielding Lake outlet	17	15	31	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	1
Fish Cr.	62	475	484	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	5
Gardiner Creek	8	118	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Little Tok R.	58	88	94	0	0	0	0	0	0	0	25	68	0	0	0	0	0	0	0	0	2
Nabesna Slough	8	8	9	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0	0	1
Other Streams (UTANANA DRAINAGE 50% of total TANANA DRAINAGE)	143	218	473	0	0	0	0	0	0	0	29	29	0	0	13	0	30	51	42	0	9
Richardson Clearwater R.	284	582	874	0	0	0	0	0	0	0	26	101	0	0	0	0	0	0	0	0	10
Rock Creek	116	168	209	0	0	0	0	0	0	0	68	85	0	0	0	0	0	0	0	0	4
Scottie Creek	16	39	93	0	0	0	0	0	0	0	0	0	0	0	0	0	25	8	0	0	1
Tok River	16	38	44	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	2
Upper Tanana drainage waters	14,886	22,395	38,016	6	603	6,928	5	471	1,887	19,372	3,265	3,607	4	342	21	6	1,106	167	1,193	143	763
% Upper management area to total	0.60	0.24	0.28	0.01	0.79	0.58	0.07	0.70	0.44	0.50	0.73	0.44	0.17	0.72	0.35	0.04	0.30	0.23	0.36	0.85	0.30
All Tanana drainage waters	24,875	92,109	137,597	498	762	11,984	76	670	4,289	38,437	4,451	8,290	24	477	60	134	3,685	719	3,295	169	2,513

**Appendix A2.-Stocking records for Delta area `lakes, 1998-1999.**

Location	Species	Date	Number Stocked	Average Length (in)	Size
Backdown Lake	Rainbow trout	8/19/98	1,200	Fingerling	2.4
Chet Lake	Lake trout	10/8/98	299	Subcatchable	5.0
Coal Mine #5	Rainbow trout	7/22/98	217	Catchable	7.4
Coal Mine #5	Rainbow trout	7/8/98	546	Catchable	7.5
Craig Lake	Rainbow trout	7/8/98	652	Catchable	7.5
Four Mile Lake	Lake trout	10/8/98	1,750	Subcatchable	5.0
Ghost Lake	Lake trout	10/8/98	295	Subcatchable	5.0
Kens Pond	Rainbow trout	8/19/98	1,000	Fingerling	2.4
Last Lake	Rainbow trout	8/19/98	1,000	Fingerling	2.4
N Twin Lake	Lake trout	10/8/98	554	Subcatchable	5.0
N Twin Lake	Rainbow trout	8/19/98	2,000	Fingerling	2.4
Nickel Lake	Lake trout	10/8/98	200	Subcatchable	5.0
Pauls Pond	Lake trout	10/8/98	297	Subcatchable	5.0
Quartz Lake	Coho salmon	10/7/98	41,209	Fingerling	3.5
Quartz Lake	Coho salmon	10/7/98	24,689	Fingerling	3.6
Quartz Lake	Rainbow trout	8/10/98	193,825	Fingerling	2.2
Quartz Lake	Rainbow trout	9/10/98	47,346	Fingerling	2.4
Quartz Lake	Rainbow trout	10/7/98	12,276	Fingerling	2.7
Quartz Lake	Rainbow trout	9/22/98	40,518	Fingerling	2.8
Quartz Lake	Rainbow trout	9/10/98	34,535	Fingerling	2.4
Rapids Lake	Lake trout	10/8/98	355	Subcatchable	5.0
Rich 81	Rainbow trout	6/10/98	300	Catchable	6.9
S Twin Lake	Rainbow trout	8/19/98	4,000	Fingerling	2.4
Weasel Lake	Rainbow trout	8/19/98	1,600	Fingerling	2.4
Backdown Lake	Arctic char	9/22/99	503	Fingerling	4.5
Big D Pond	Rainbow trout	5/26/99	1,473	Catchable	8.5
Bluff Cabin Lake	Rainbow trout	7/26/99	6,905	Fingerling	2.1
Bolio Lake	Rainbow trout	5/26/99	2,586	Catchable	9.3
Brodie Lake	Arctic char	9/22/99	434	Fingerling	4.5
Brodie Lake	Arctic grayling	6/7/99	45	Catchable	8.2
Brodie Lake	Arctic grayling	6/7/99	275	Catchable	8.8
Bullwinkle Lake	Rainbow trout	8/9/99	833	Fingerling	2.2
Chet Lake	Rainbow trout	8/9/99	1,667	Fingerling	2.2
Coal Mine #5	Rainbow trout	6/7/99	333	Catchable	10.4
Craig Lake	Rainbow trout	5/26/99	435	Catchable	9.3
Dicks Pond	Arctic char	9/22/99	434	Fingerling	4.5

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**Appendix A2 –Page 2 of 3.**

Location	Species	Date	Number Stocked	Average Length (in)	Size
Doc Lake	Rainbow trout	8/9/99	556	Fingerling	2.2
Donna Lake	Rainbow trout	7/26/99	11,488	Fingerling	2.1
Donnelly Lake	Arctic char	9/22/99	4,939	Fingerling	4.5
Donnelly Lake	Rainbow trout	8/9/99	13,278	Fingerling	2.2
Forest Lake	Rainbow trout	7/26/99	2,500	Fingerling	2.1
Four Mile Lake	Rainbow trout	7/30/99	20,000	Fingerling	2.2
Ghost Lake	Rainbow trout	8/9/99	1,111	Fingerling	2.2
Hidden Lake	Rainbow trout	8/12/99	4,022	Fingerling	2.0
J Lake	Arctic grayling	6/7/99	536	Catchable	8.8
Jan Lake	Rainbow trout	7/30/99	9,036	Fingerling	2.2
Kens Pond	Arctic char	9/22/99	434	Fingerling	4.5
L Donna Lake	Rainbow trout	7/26/99	6,000	Fingerling	2.1
Last Lake	Arctic char	9/22/99	434	Fingerling	4.5
Lisa Lake	Rainbow trout	7/26/99	10,000	Fingerling	2.1
Little Lost Lake	Rainbow trout	5/26/99	500	Catchable	9.3
Luke Lake	Arctic grayling	6/7/99	300	Catchable	8.2
Mark Lake	Rainbow trout	8/9/99	9,155	Catchable	2.2
Monte Lake	Rainbow trout	7/26/99	18,000	Catchable	2.1
N Twin Lake	Rainbow trout	8/9/99	2,000	Catchable	2.2
Nickel Lake	Arctic grayling	6/7/99	250	Fingerling	8.8
Nickel Lake	Rainbow trout	8/9/99	1,111	Catchable	2.2
No Mercy Lake	Rainbow trout	8/9/99	666	Fingerling	2.2
Pauls Pond	Arctic grayling	6/7/99	250	Catchable	8.2
Quartz Lake	Arctic char	8/22/99	11,047	Fingerling	3.9
Quartz Lake	Coho salmon	6/3/99	78,727	Fingerling	2.9
Quartz Lake	Rainbow trout	7/26/99	228	Fingerling	2.1
Quartz Lake	Rainbow trout	7/27/99	294,593	Fingerling	2.1
Quartz Lake	Rainbow trout	8/22/99	647	Catchable	6.3
Rainbow Lake	Rainbow trout	7/26/99	7,000	Fingerling	2.1
Rangeview Lake	Arctic char	9/22/99	434	Fingerling	4.5
Rangeview Lake	Arctic grayling	6/7/99	240	Catchable	8.8
Rapids Lake	Rainbow trout	8/9/99	1,000	Fingerling	2.2
Rich 81	Rainbow trout	5/26/99	300	Catchable	9.3
Robertson Lake #2	Rainbow trout	7/26/99	3,000	Fingerling	2.1
Rockhound Lake	Rainbow trout	8/9/99	666	Fingerling	2.2
S Johnson Lake	Rainbow trout	7/26/99	1,400	Fingerling	2.1

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**Appendix A2 –Page 3 of 3.**

Location	Species	Date	Number Stocked	Average Length (in)	Size
S Twin Lake	Rainbow trout	8/9/99	4,444	Fingerling	2.2
Shaw Pond	Arctic char	9/22/99	359	Fingerling	4.5
Shaw Pond	Rainbow trout	5/26/99	1,000	Catchable	9.3
Weasel Lake	Rainbow trout	7/26/99	1,600	Fingerling	2.1

## **APPENDIX B**

**Appendix B1.-Study by Tim Viavant “A comparison of snorkel-count and mark-recapture abundance estimates of Arctic grayling in the Delta Clearwater River, 1998”.**

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## **ABSTRACT**

Two observers snorkeling the Delta Clearwater River obtained three replicate visual counts of adult Arctic grayling. Counts of the surveyed area were made in one-mile segments from river mile 14 to river mile 3. The average total count for all three replicates was 1,915 (SE = 99). This represents 33% of an estimate obtained by mark-recapture methods. Snorkel counts were highly variable between replicates of the same river mile (cv's ranged from 9% to 55%), but variability of the total count between replicates was low (cv = 5%).

Key words: Arctic grayling *Thymallus arcticus*, snorkel counts, underwater observation

## **INTRODUCTION**

Management of the Delta Clearwater River's (DCR) Arctic grayling (hereafter called grayling) fishery, as well as assessment of its recent catch-and-release regulations, requires, at the least, a long-term program that precisely and accurately monitors abundance. Budget limitations and priorities as well as public perceptions and opinion can have a major influence on the type of monitoring program used. The present monitoring program (entering its third year) uses angling for a mark-recapture experiment to estimate absolute abundance and age and size compositions. The program is costly in both time and manpower with data collection taking two weeks to conduct and costing an average of 108 man-days. Underwater observation by snorkeling is an alternative methodology, which could provide either an absolute or relative estimate of abundance at substantial time and manpower savings. The shallow (1 to 10 ft), clear waters of the spring-fed DCR meet the foremost requirement of the method, the ability to see fish (Schill and Griffith 1984). This study investigates how this potential management tool translates into accurate and precise enumeration of DCR grayling by providing a comparison with the present monitoring program.

For over 30 years, underwater observation of fish has been found to be a valuable tool in the study of salmonids in rivers and streams (Thurrow 1994). Studies have included assessment of habitat use, spatial, species, and size distributions, and abundance estimation. The latter studies include population estimation by direct enumeration (Northcote and Wilkie 1963, Hankin and Reeves 1988, Hillman et al. 1992, Thurrow and Schill 1996), by mark-recapture methods using underwater divers to determine tagged to untagged ratios (Slaney and Martin 1987, Zubik and Fraley 1988), for estimating relative abundance by density (Schill and Griffith 1984), and for estimating age-frequency distributions (Griffith 1981). Methods used in abundance estimation have varied from relatively simple replicated counts (Northcote and Wilke 1963, Zubik and Fraley 1988) to complicated stratified sampling designs involving habitat type (Hankin and Reeves 1988). While variation in density estimates between individual divers and replicate counts has been found to be small (Schill and Griffith 1984, Zubik and Fraley 1988, Thurrow 1994), the accuracy of snorkel estimates has been difficult to assess because the

true abundance is usually unknown. Thurow (1994) reviewed the relationship between snorkel estimates and other abundance estimates from 13 studies and found that snorkel estimates were within 70% of actual abundance estimates in all but two cases. Individual relationships ranged from 22% to 105% and were dependent on the type of stream (habitat and abundance of cover), size of fish counted (small fish were harder to see), and on the precision and accuracy of the method used for comparison.

Unlike the above studies that had abundance estimation as objectives, the overall objective of this study was to evaluate snorkel counts from two observers as a management tool to obtain a consistent index of abundance. The snorkel survey is somewhat constrained by using just two observers given the average width of the stream (124ft), and the maximum width surveyed by two observers in a 1997 trial (48 ft). Given that grayling are not evenly distributed across the width of the stream, the probability of an undercount is unknown, but undercounting is very likely. However, the DCR snorkel counts need not be accurate in estimating absolute abundance but do need to be precise to estimate relative abundance and its relationship to absolute abundance (as estimated using mark-recapture methodology). A direct count, if precise, provides at least a minimum count of fish present and gives the opportunity for an inexpensive, long-term program to monitor trends in relative abundance. Although the method has been shown to generally under-represent estimates obtained by other means, visual counts that consistently provide relatively precise proportions of other estimates of abundance are still very useful as a management tool, particularly when the costs of obtaining each type of estimate are considered (Thurow 1994, Mullner and Hubert *In press*).

The tasks associated with this study were to determine the proportion of the concurrent mark-recapture estimate observed by visual counts, to estimate the variability between three replicate counts, and the variability within observers between counts.

## METHODS

Snorkel counts were conducted in the same area of river assessed by conventional mark-recapture means, from mile 14 of the river downstream to mile 3. In departmental surveys in July from 1995 through 1997, grayling have been few or absent upstream of the forks at mile 14 to mile 15 of the Sawmill fork and non-existent further upstream (Figure 1). (Grayling were not found in the North Fork during surveys in the late 1970's.) The lower 2 miles were not surveyed due to scarcity of fish and so that counts could be compared to the mark-recapture study.

Counts were conducted in one mile sections, from upstream to downstream, beginning at mile 14. Divers swam parallel to each other and maintained spacing equal to or less than each day's underwater visibility using a length of pvc pipe. Each observer counted all Arctic grayling passing by them from a middle mark on the pvc pipe to their respective bank or limit of visibility and recorded the number in large ( $\geq 270$  mm) and small ( $\leq 270$  mm) size classes on mechanical counting devices, one in each hand. Counts were recorded by mile section for each observer.

A crew of three was used during all counts: two observers equipped with dry suits and one "tender" in a boat who followed the observers at all times. Observers and tender

frequently checked stream conditions downstream in order to avoid any instream hazards. An air horn was used to warn observers of hazards and mile markers. All counts were conducted during periods of low public use (0900 to 1700 hr during weekdays). In addition, signs were placed on the river above and below the State boat launch at mile 8 cautioning boaters that swimmers were in the water.

Each day prior to counting, underwater visibility was determined as the maximum distance at which multiple silhouettes and/or carcasses of round whitefish and grayling of two size classes ( $\leq 270$  mm FL and  $\geq 270$  mm FL) could be clearly recognized. This distance was used to determine the limit of spacing between the divers during counts as well as the width of river surveyed. Spacing of the divers was maintained with a 1.5in (38mm) diameter pvc pipe. Weather conditions were also recorded as sunny, partly cloudy, cloudy, or rain.

Counts occurred in 1 mile increments lasting approximately 24 minutes. After 3 counts were conducted, at least a 30 minute rest period was taken due to cold water temperatures ( $6^{\circ}\text{C}$  -  $8^{\circ}\text{C}$ ). Counts were conducted from river mile 14 down, with each pass of the entire counted area completed before starting the next pass.

Because the majority of the river is too wide for divers to see from bank to bank (Figure 1), swimmers counted in the area of the channel with habitat most likely to contain grayling or where the most fish were observed. Given grayling behavior during feeding and resting, it is unlikely there was uniform distribution of fish across the width of the river at any point. Since the river is spring fed and not susceptible to freshets, portions of the river outside of the main channel have substrate of predominantly mud and detritus lacking large woody debris. When necessary, especially along river mile 4 and 3, the tender placed buoys in the channel/bank indicating the portion of channel/bank counted in the first pass so that replicate counts took place in the same portion of the channel/bank. In most sections, the portion of river counted was mid-channel.

The position of each observer relative to river bank (left versus right) was randomized for each one-mile section to ensure independence of the total count for each pass and to avoid confounding of between pass variation with within diver variation. This design is similar to a crossover design described in Milliken and Johnson (1984, p.440), however we were not concerned about the crossover.

Each day, prior to counting, data on underwater visibility distance, weather conditions, and location and time of counts was recorded in a field notebook. At the end of each mile section, counts of each size class from each observer and observer position (left or right side) were recorded in the field notebook by the tender, and the mechanical counters reset. Those sections requiring buoys and their general location was also be recorded. The average total counts and associated variance (by size class, by observer, and the overall total) were calculated with simple sample mean and variance statistics (Snedecor and Cochran, 1980).

## RESULTS AND DISCUSSION

The average total number of Arctic grayling counted by both observers was 1,915 fish (SE = 99) (Table 1). This represents 34% of the population estimated for the survey area by mark-recapture methods (Ridder 1999). The average number of fish greater than 270mm counted by both observers was 1,235 (SE = 233). The average total number of fish counted for each of the two observers was 879 (Obs. 1, SE = 40) and 1035 (Obs. 2, SE = 124).

The variability between individual replicate one-mile counts was relatively high, with coefficients of variation ranging from 9% to over 50% (Table 1). This is probably a result of a combination of between-replicate observer variability (light conditions, fatigue), variability between the two observers, and fish movement between replicate counts. Fish were observed by snorkels during each pass to move downstream as snorkels moved downstream, bunching up as the snorkels moved down a riffle/run section of the river, and then all passing upstream past the snorkels when they reached a pool section of river. It is possible that fish displaced in this way took some time to move back upstream into the feeding areas they were displaced from. Counting conditions also changed, at least slightly, throughout the day, and between days, based on angle of the sun, and presence/absence of cloud cover or haze. Condition of the counters also changed during each day due to cold and fatigue.

### Appendix B2.-Summary of Arctic grayling replicate snorkel counts from the Delta Clearwater River, Alaska, 1998.

Fish greater than 270 mm							All Fish					
Mile	Rep1	Rep2	Rep3	AVE	VAR	SE	Rep1	Rep2	Rep3	AVE	VAR	SE
14	161	72	81	105	2400	49	261	111	108	160	7653	87
13	138	113	157	136	487	22	232	136	191	186	2320	48
12	81	80	165	109	2380	49	146	111	228	162	3606	60
11	78	144	149	124	1570	40	131	208	204	181	1879	43
10	52	79	134	88	1746	42	93	107	161	120	1289	36
9	50	146	160	119	3585	60	237	307	236	260	1657	41
8	78	145	110	111	1123	34	167	233	144	181	2134	46
7	71	79	84	78	43	7	126	118	140	128	124	11
6	100	80	106	95	185	14	153	118	149	140	367	19
5	77	94	128	100	674	26	128	143	207	159	1760	42
4	71	142	159	124	2179	47	113	208	215	179	3246	57
3	53	46	42	47	31	6	80	50	46	59	345	19
	1,010	1,220	1,475	1,235	54,225	233	1,867	1,850	2,029	1,915	9,762	99

Coefficient of Variation= 19%

Coefficient of Variation = 5%

There were notable differences in number of fish counted and in variability between replicate counts between the two counters (observer 2 overall counted more fish, and consistently had higher variability between replicates than observer 1). These differences could result from differences in eyesight or ability to resist fatigue (attentiveness).

Although variability in counts between replicates of one-mile sections was high, the low variability between replicates total counts (CV of less than 5%) indicates that using snorkel counts as an index of abundance of Arctic grayling in the Delta Clearwater River could be a valid management tool. This is the case, even though snorkel counting only counted a portion (around 34%) of the number of fish estimated by the concurrent mark-recapture estimate, provided that this proportion was relatively consistent.

A major argument for the use of a snorkel survey for use as a population index for management purposes is the relative cost of obtaining the information compared to the cost of conducting a mark-recapture estimate. A snorkel survey of the DCR can be conducted without replication for less than five days of staff time. This represents 3.3% of the 150 days of staff time needed to conduct the mark-recapture estimate the last three years. Obviously, the information provided by each of the methods are not comparable, since the mark-recapture estimate provides an estimate of absolute abundance and also provides other population parameters of interest. However, if the management of the Arctic grayling fishery in the DCR requires an ongoing assessment, a snorkel survey abundance index appears to be a cost effective option. Before relying on this method as a management tool, the experiment should be repeated to further evaluate the relationship between the two estimators, and to further validate the low variability between replicates of the snorkel survey abundance index.

**Appendix B3.-Individual replicate snorkel counts by observer and size class of Arctic grayling in the Delta Clearwater River, Alaska, 1998.**

Date	Replicate	Mile	Observer	<270	>270	Observer	<270	>270	Total(1)	subT>270	subT<270
7/20/98	1	14	1	41	97	2	59	64	261	161	100
7/20/98	1	13	2	36	63	1	58	75	232	138	94
7/20/98	1	12	1	26	33	2	39	48	146	81	65
7/20/98	1	11	2	19	32	1	34	46	131	78	53
7/20/98	1	10	1	23	29	2	18	23	93	52	41
7/20/98	1	9	2	106	27	1	81	23	237	50	187
7/21/98	1	8	1	22	26	2	67	52	167	78	89
7/21/98	1	7	2	19	28	1	36	43	126	71	55
7/21/98	1	6	1	12	27	2	41	73	153	100	53
7/21/98	1	5	1	17	26	2	34	51	128	77	51
7/21/98	1	4	2	26	50	1	16	21	113	71	42
7/21/98	1	3	2	11	27	1	16	26	80	53	27
Replicate 1 Totals				358	465		499	545	1867	1010	857

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Date	Replicate	Mile	Observer	<270	>270	Observer	<270	>270	Total(2)	SubT>270	subT<270
7/21/98	2	14	1	14	34	2	25	38	111	72	39
7/21/98	2	13	1	16	47	2	7	66	136	113	23
7/21/98	2	12	2	14	42	1	17	38	111	80	31
7/22/98	2	11	1	29	62	2	35	82	208	144	64
7/22/98	2	10	2	6	50	1	22	29	107	79	28
7/22/98	2	9	2	53	57	1	108	89	307	146	161
7/22/98	2	8	1	47	78	2	41	67	233	145	88
7/22/98	2	7	1	14	36	2	25	43	118	79	39
7/22/98	2	6	2	19	39	1	19	41	118	80	38
7/22/98	2	5	2	27	47	1	22	47	143	94	49
7/22/98	2	4	2	31	78	1	35	64	208	142	66
7/22/98	2	3	1	4	14	2	0	32	50	46	4
Replicate 2 totals				274	584		356	636	1850	1220	630

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Date	Replicate	Mile	Observer	<270	>270	Observer	<270	>270	Total(1)	subT>270	subT<270
7/22/98	3	14	2	8	33	1	19	48	108	81	27
7/22/98	3	13	1	19	68	2	15	89	191	157	34
7/22/98	3	12	1	38	54	2	25	111	228	165	63
7/23/98	3	11	2	7	53	1	48	96	204	149	55
7/23/98	3	10	2	11	92	1	16	42	161	134	27
7/23/98	3	9	1	19	36	2	57	124	236	160	76
7/23/98	3	8	2	12	71	1	22	39	144	110	34
7/23/98	3	7	1	16	32	2	40	52	140	84	56
7/23/98	3	6	1	18	26	2	25	80	149	106	43
7/23/98	3	5	2	30	72	1	49	56	207	128	79
7/23/98	3	4	1	19	61	2	37	98	215	159	56
7/23/98	3	3	2	0	28	1	4	14	46	42	4
Replicate 3 totals				197	626		357	849	2029	1475	554